US008597358B2

(12) **United States Patent**
Landry et al.

(10) **Patent No.: US 8,597,358 B2**
(45) **Date of Patent: Dec. 3, 2013**

(54) **DYNAMIC INTERBODY DEVICES**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1350 days.

(21) Appl. No.: **11/655,737**

(22) Filed: **Jan. 19, 2007**

(65) **Prior Publication Data**

US 2008/0234732 A1 Sep. 25, 2008

(51) **Int. Cl.**
A61F 2/44 (2006.01)
A61B 17/70 (2006.01)

(52) **U.S. Cl.**
USPC **623/17.15**; 606/246

(58) **Field of Classification Search**
USPC 606/247–249; 623/17.11–17.16
See application file for complete search history.

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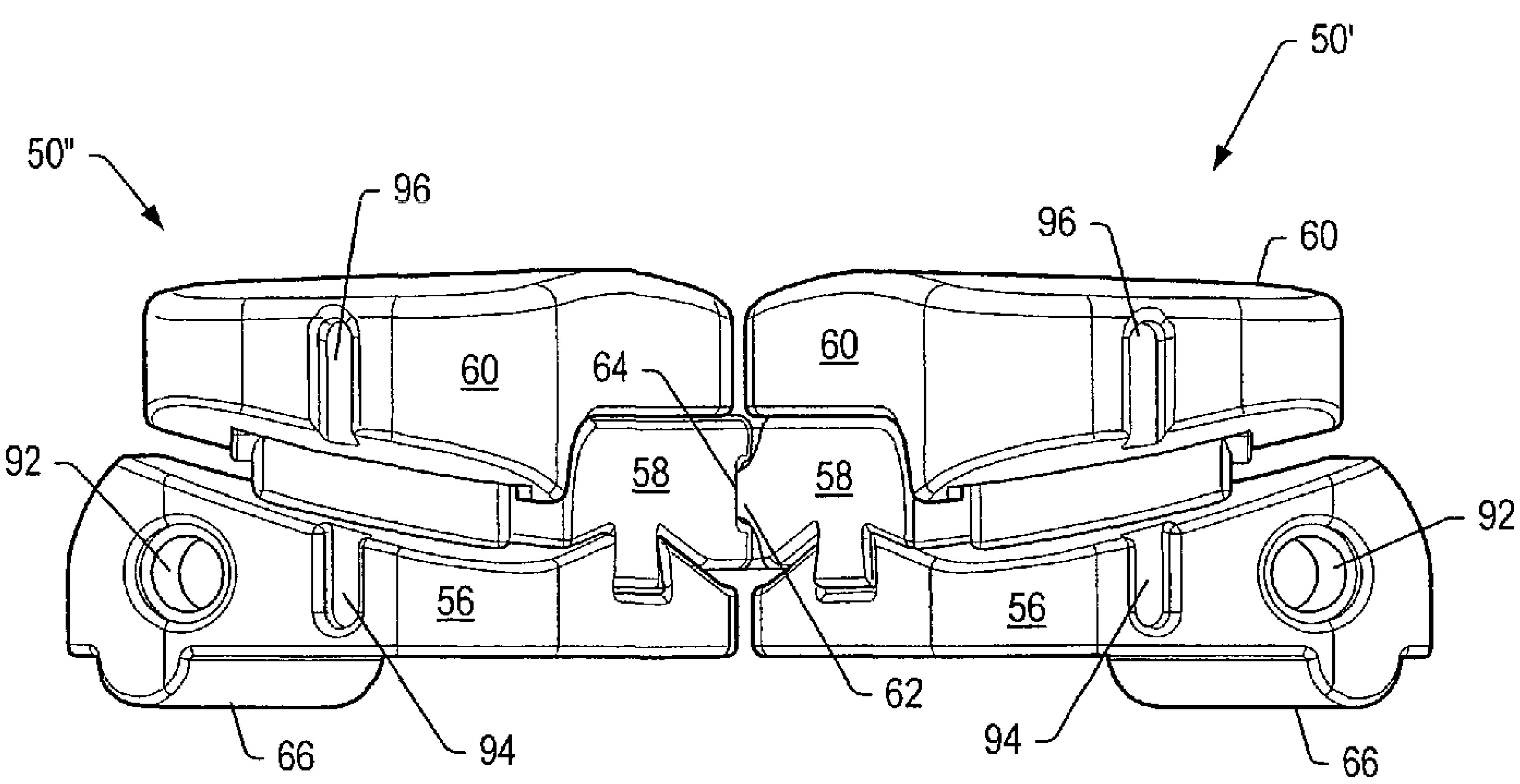
(57) **ABSTRACT**

A stabilization system for a human spine is provided. The stabilization system may include two dynamic interbody devices and/or one or more dynamic posterior stabilization systems. The dynamic interbody devices may be inserted into a disc space using a posterior approach. A first portion of a dynamic interbody device may contact a lower vertebra. A second portion of the dynamic interbody device may contact an upper vertebra. The first portion may be wider than the second portion to facilitate a large contact area against the lower vertebra and to facilitate insertion of the dynamic interbody device in the available space. The dynamic interbody devices may allow for coupled axial rotation and lateral bending of vertebrae adjacent to the dynamic interbody devices. The dynamic posterior stabilization systems may provide resistance to movement that mimics the resistance provided by a normal functional spinal unit.

17 Claims, 22 Drawing Sheets



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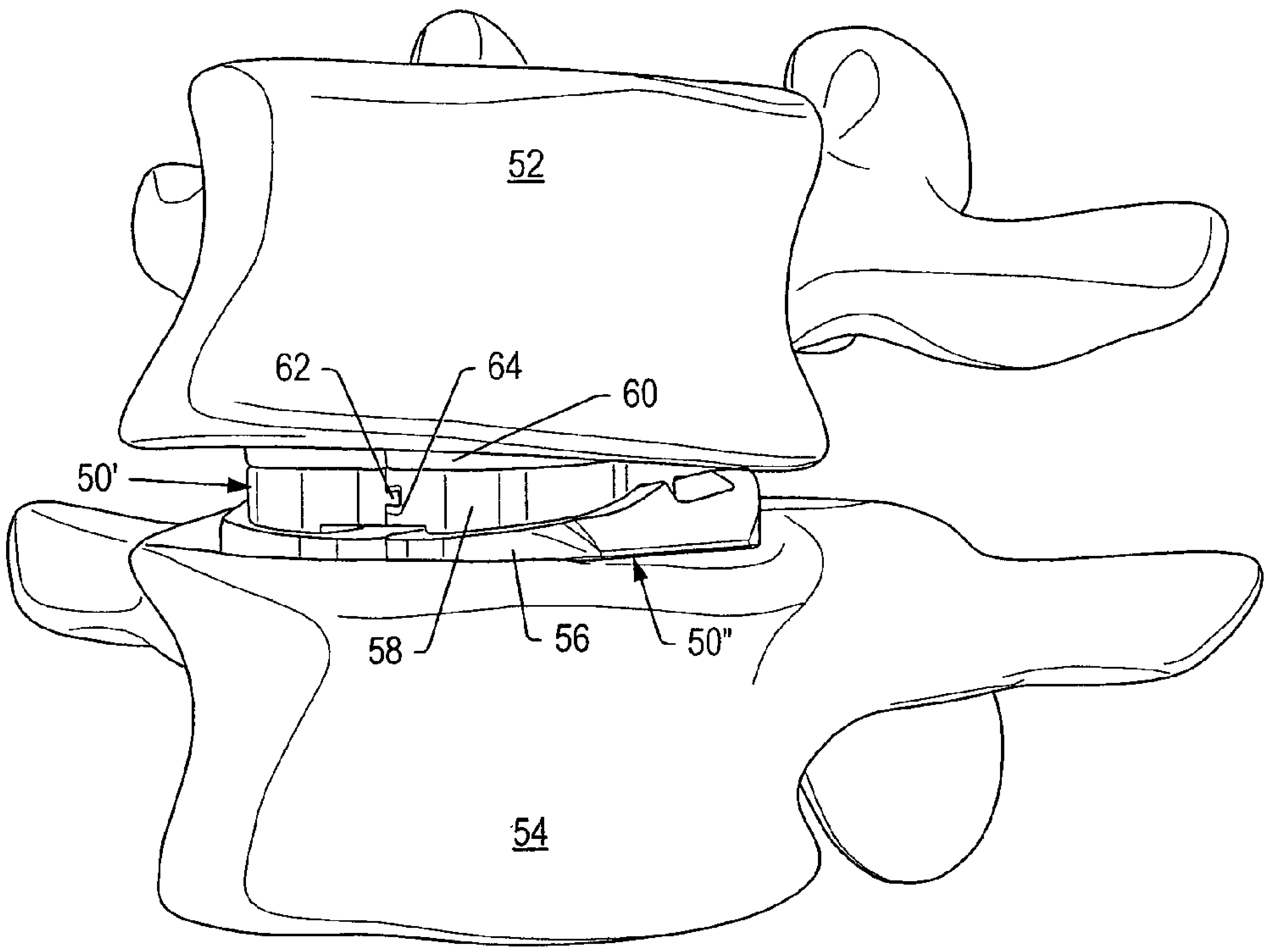
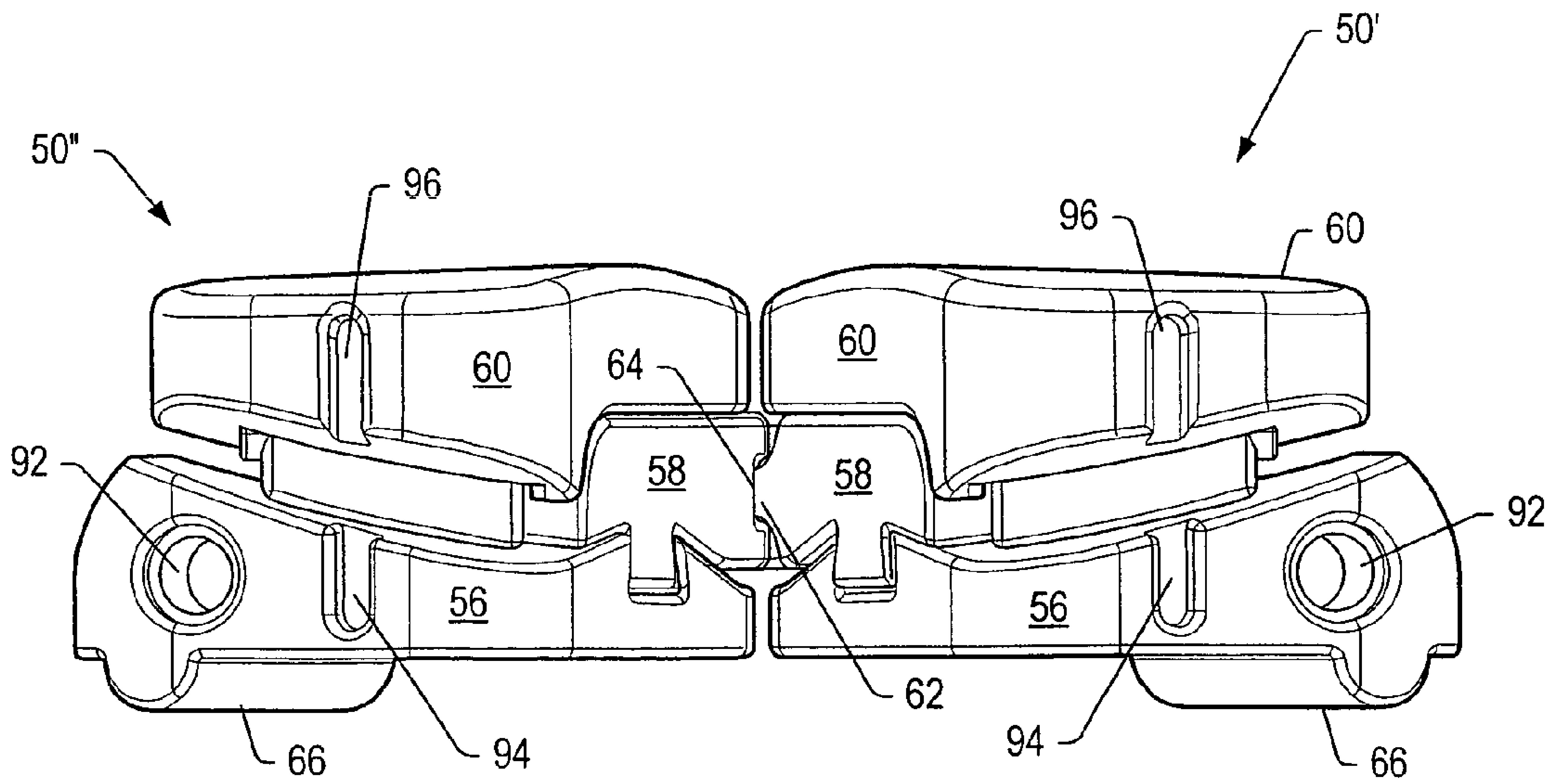
J.P. Notice of Reason for Refusal for Japanese Application No. 2009-546510 mailed on Oct. 9, 2012.

* cited by examiner



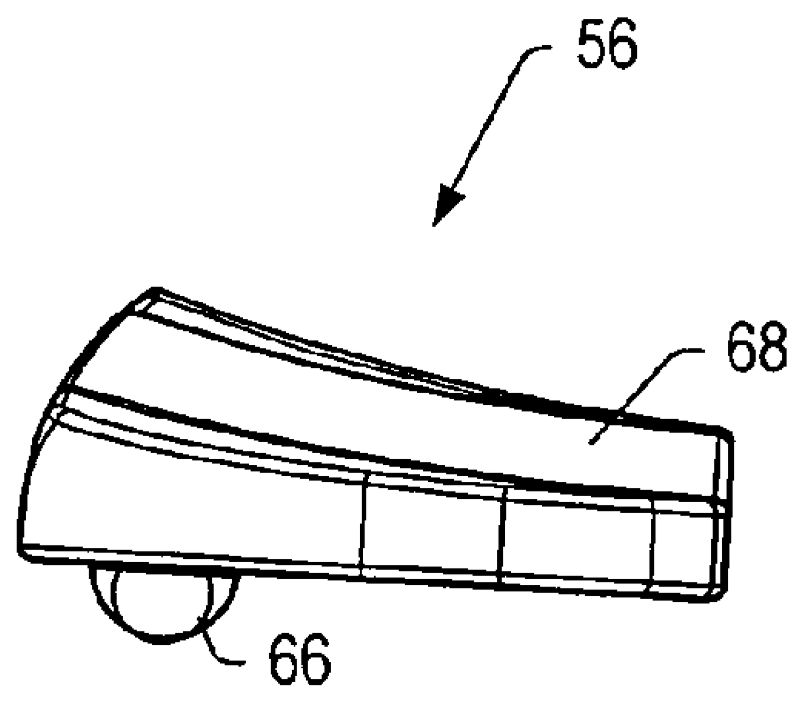
52
62
64
60
50'
58
56
50"
54

FIG. 1



50'
50"
96
96
60
60
60
64
92
58
58
92
56
56
62
94
94
66
66

FIG. 2



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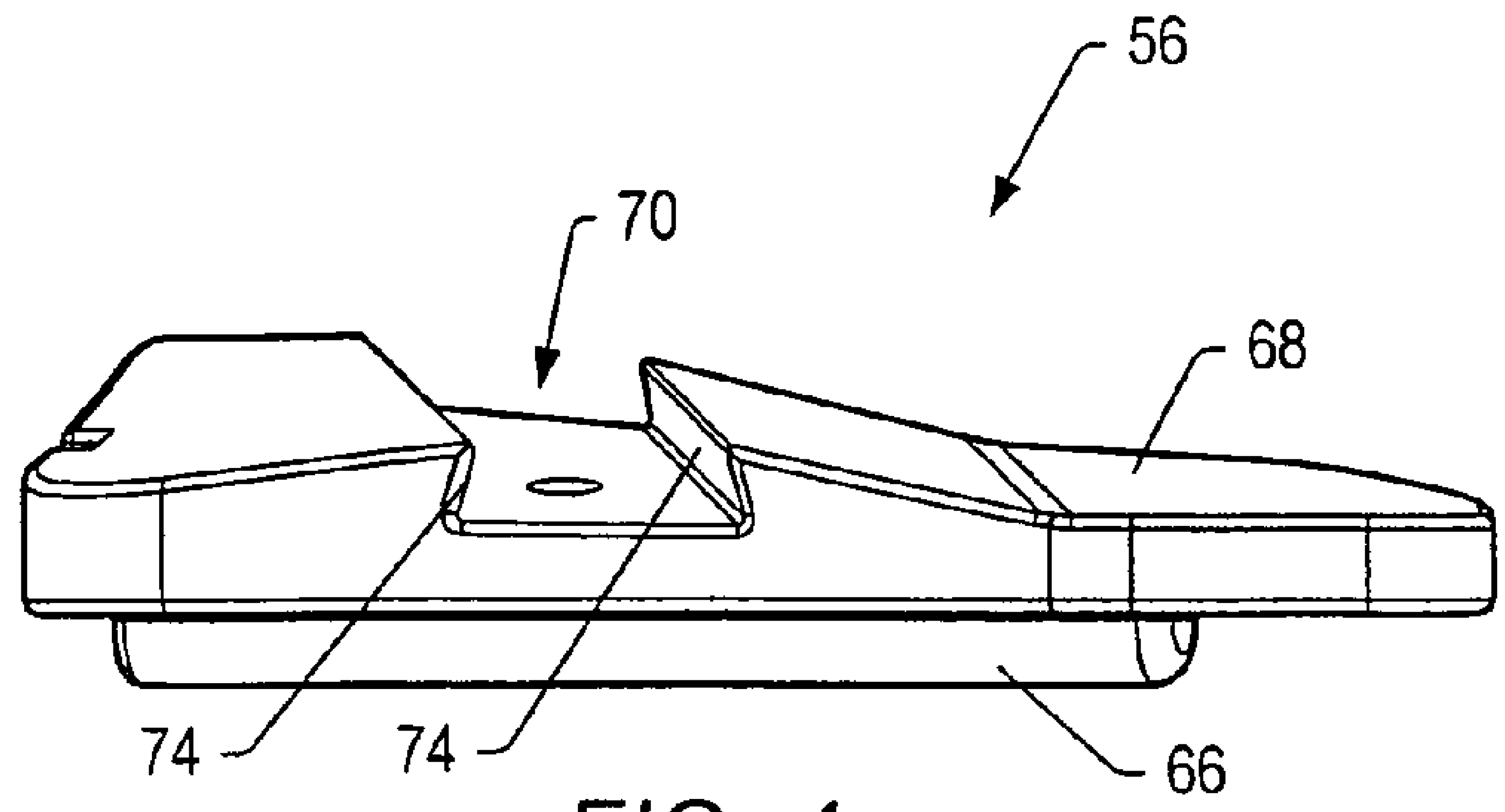


FIG. 4

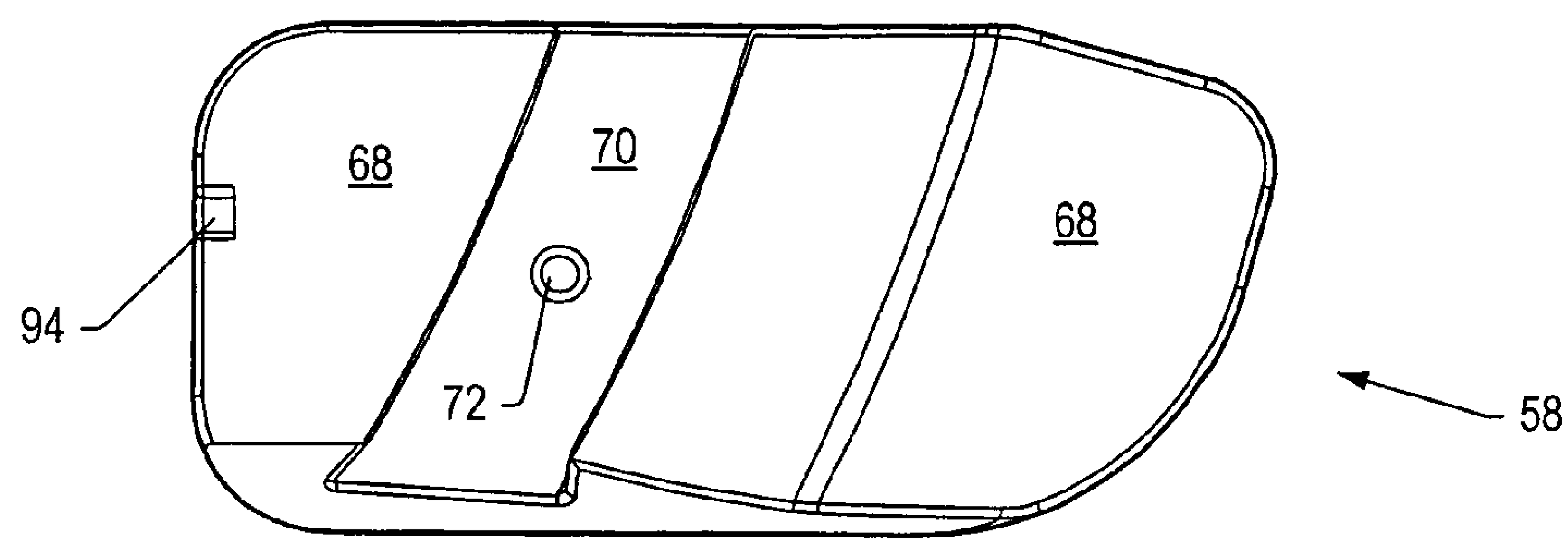


FIG. 5

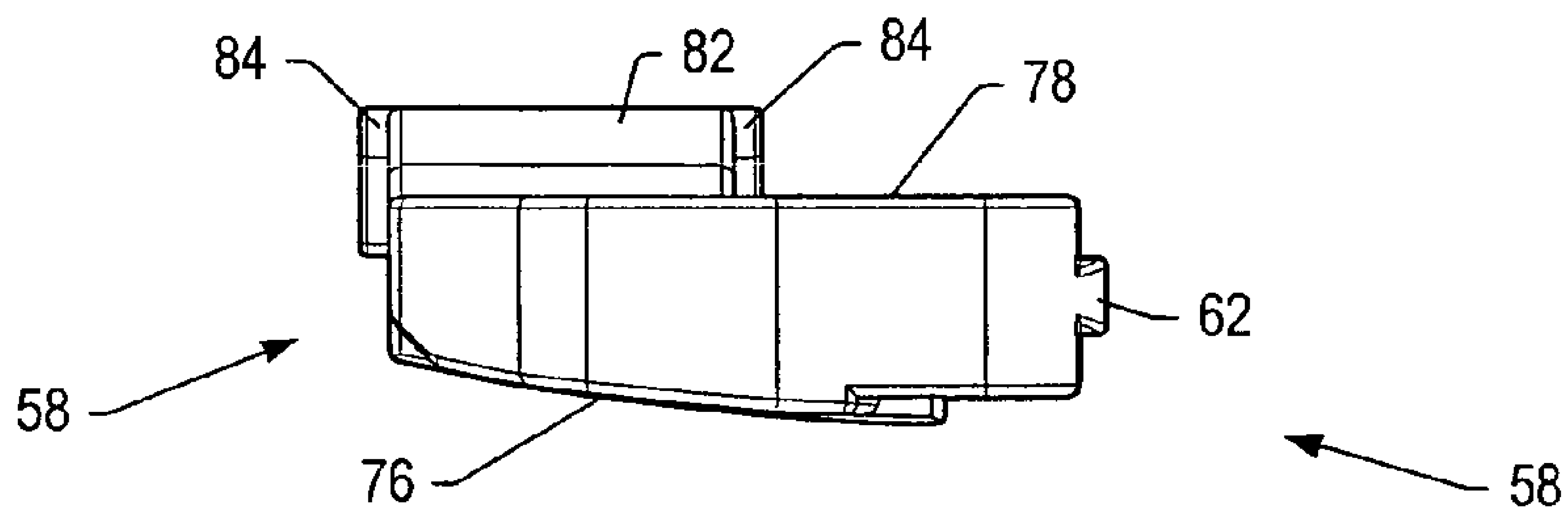


FIG. 6

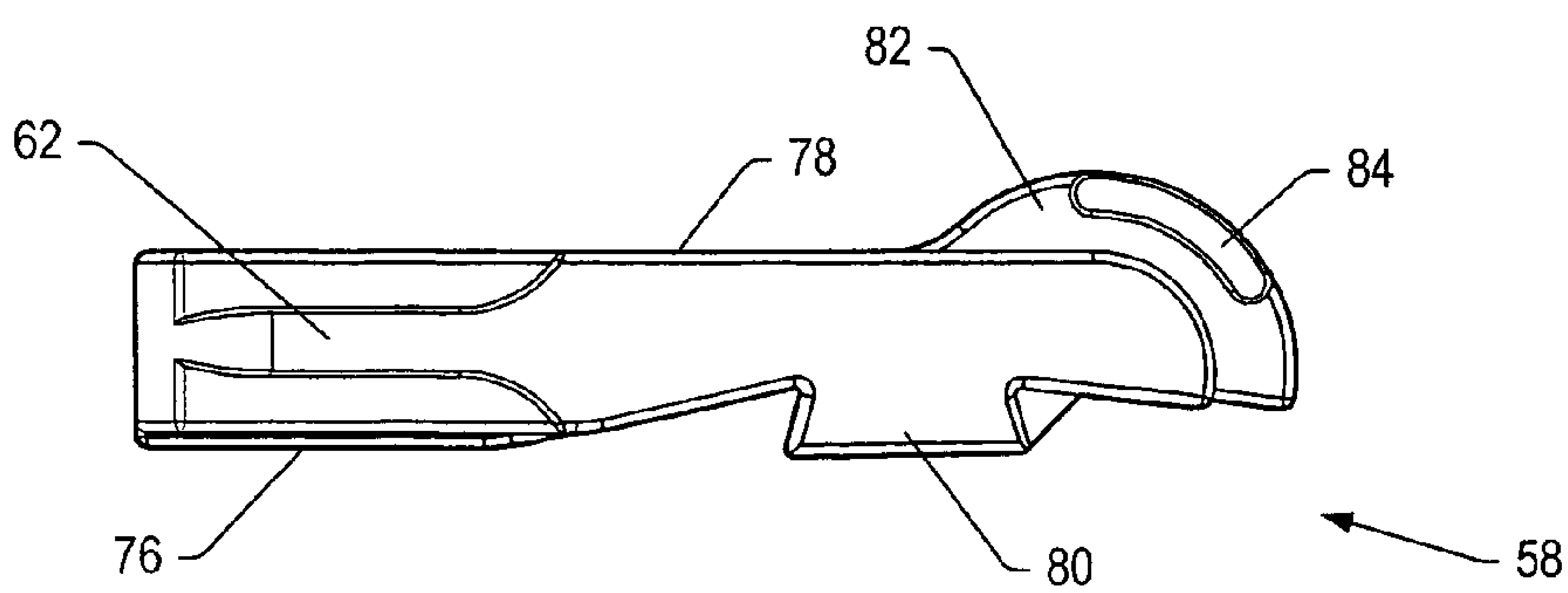


FIG. 7

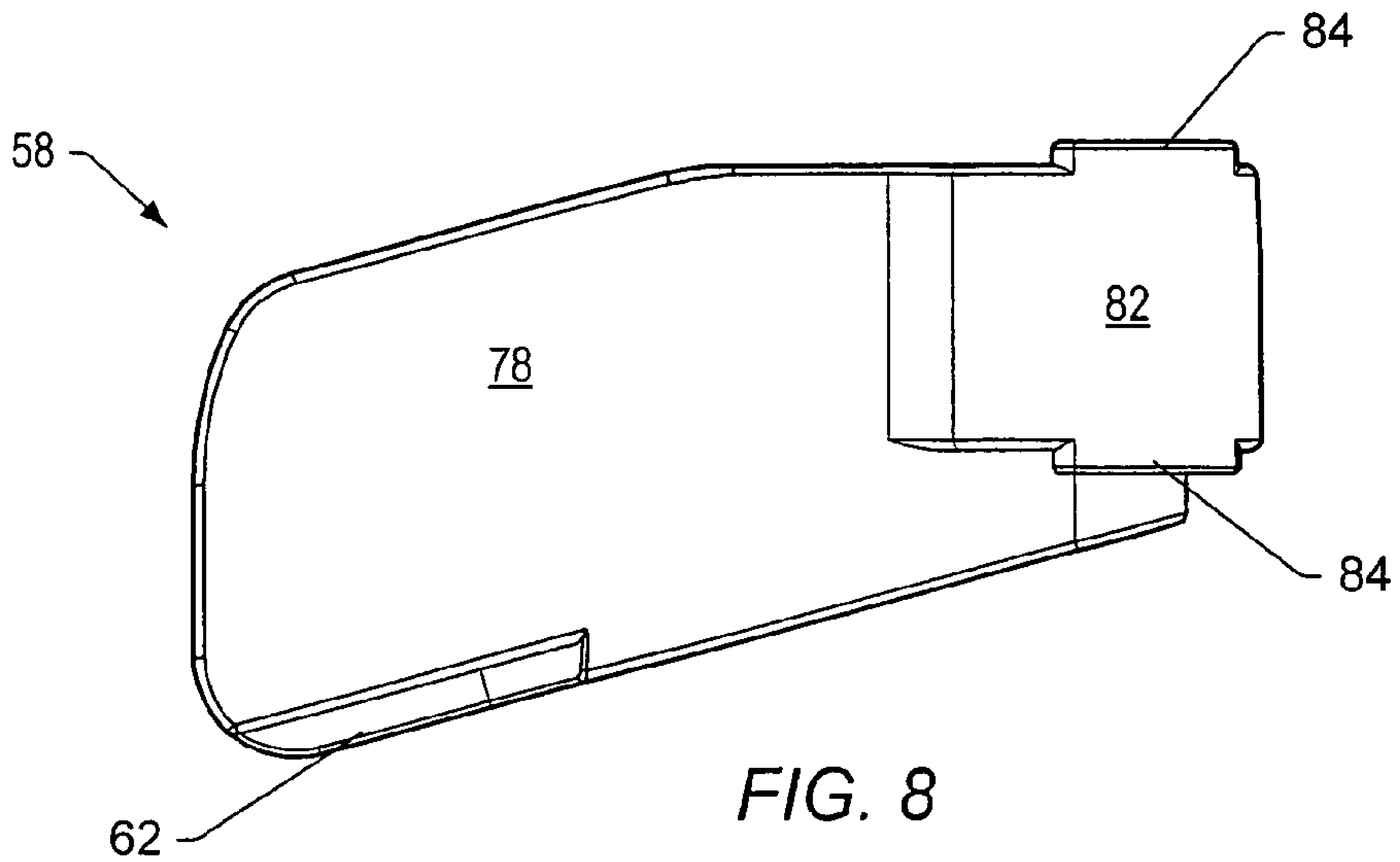


FIG. 8

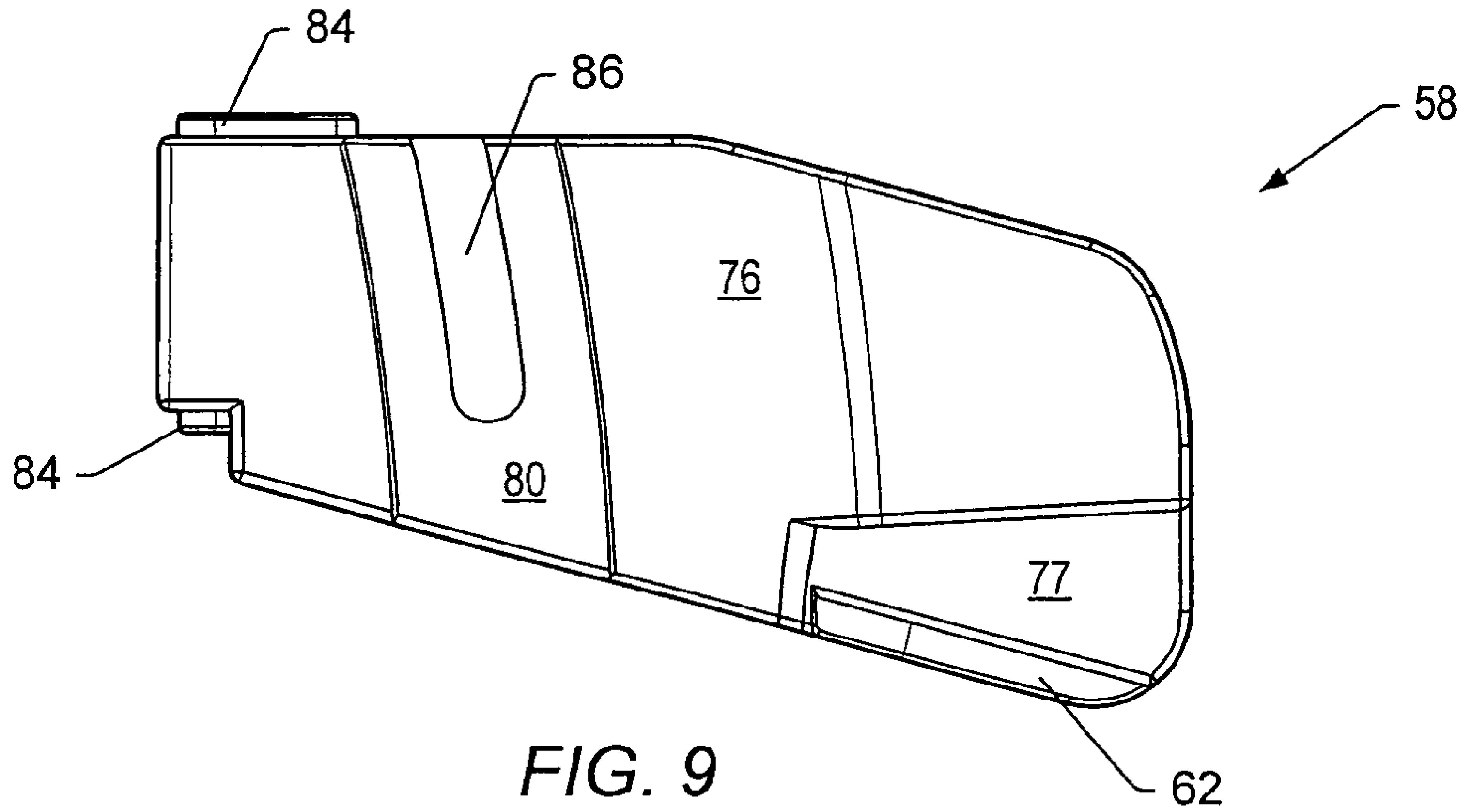


FIG. 9

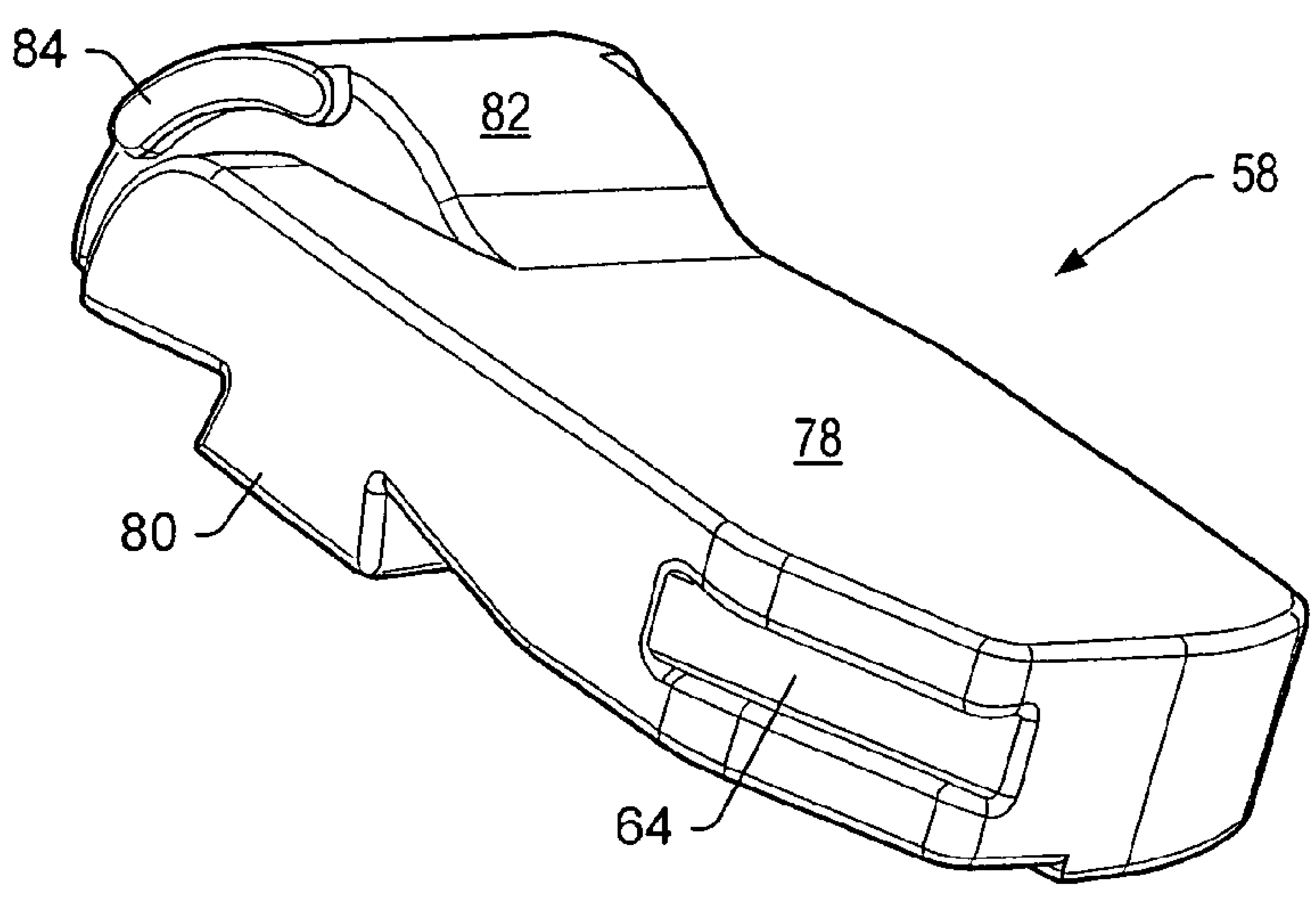


FIG. 10

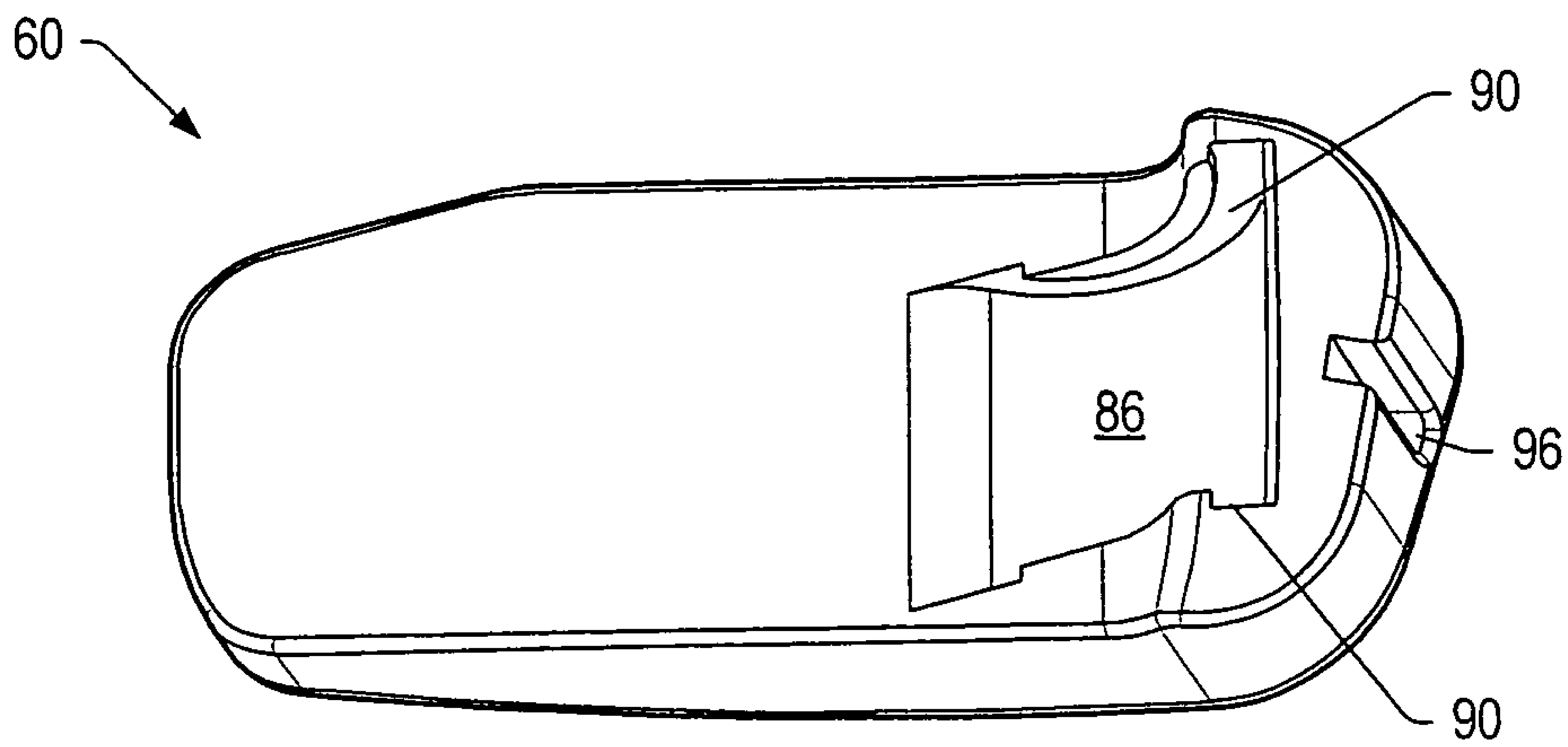


FIG. 11

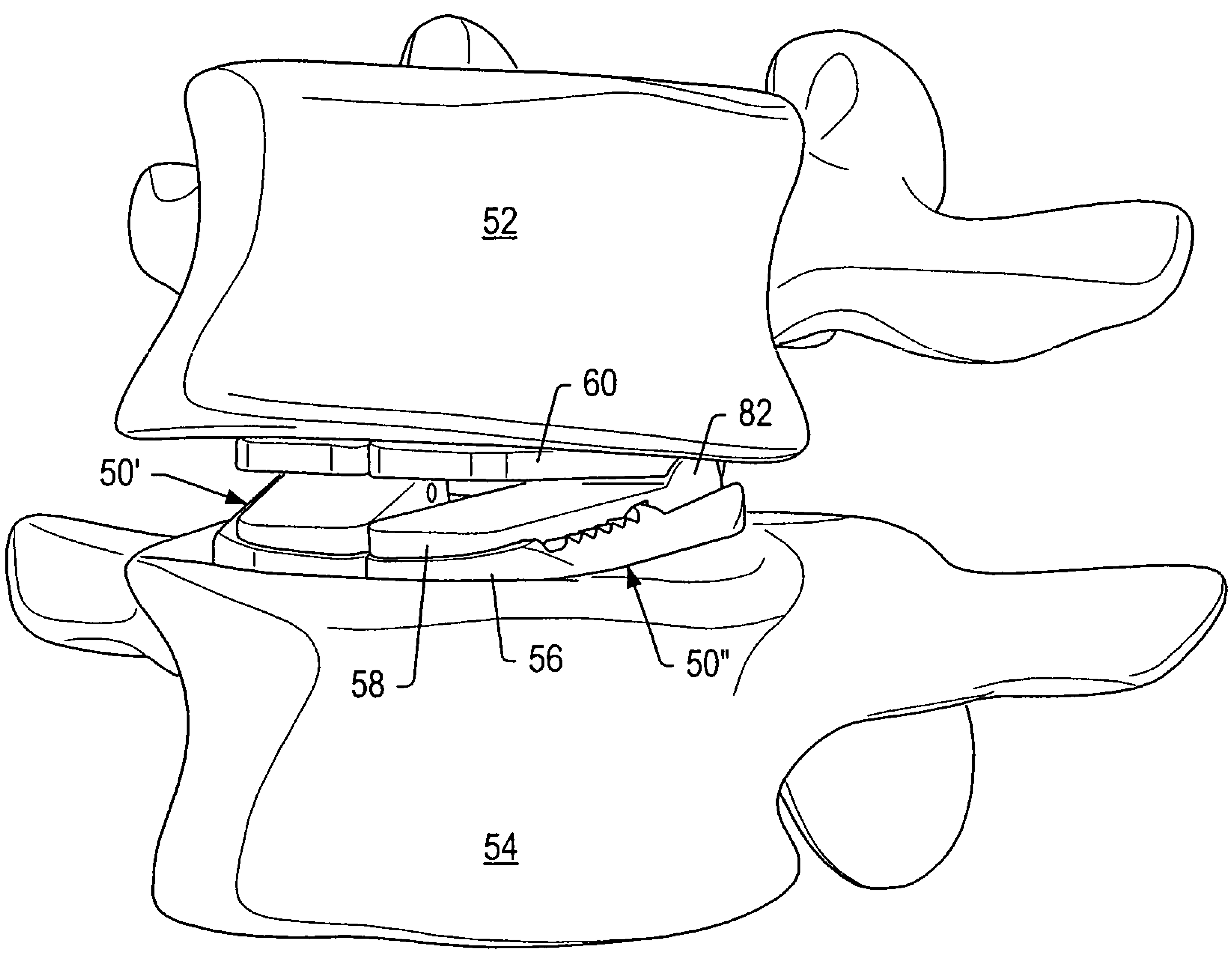


FIG. 12

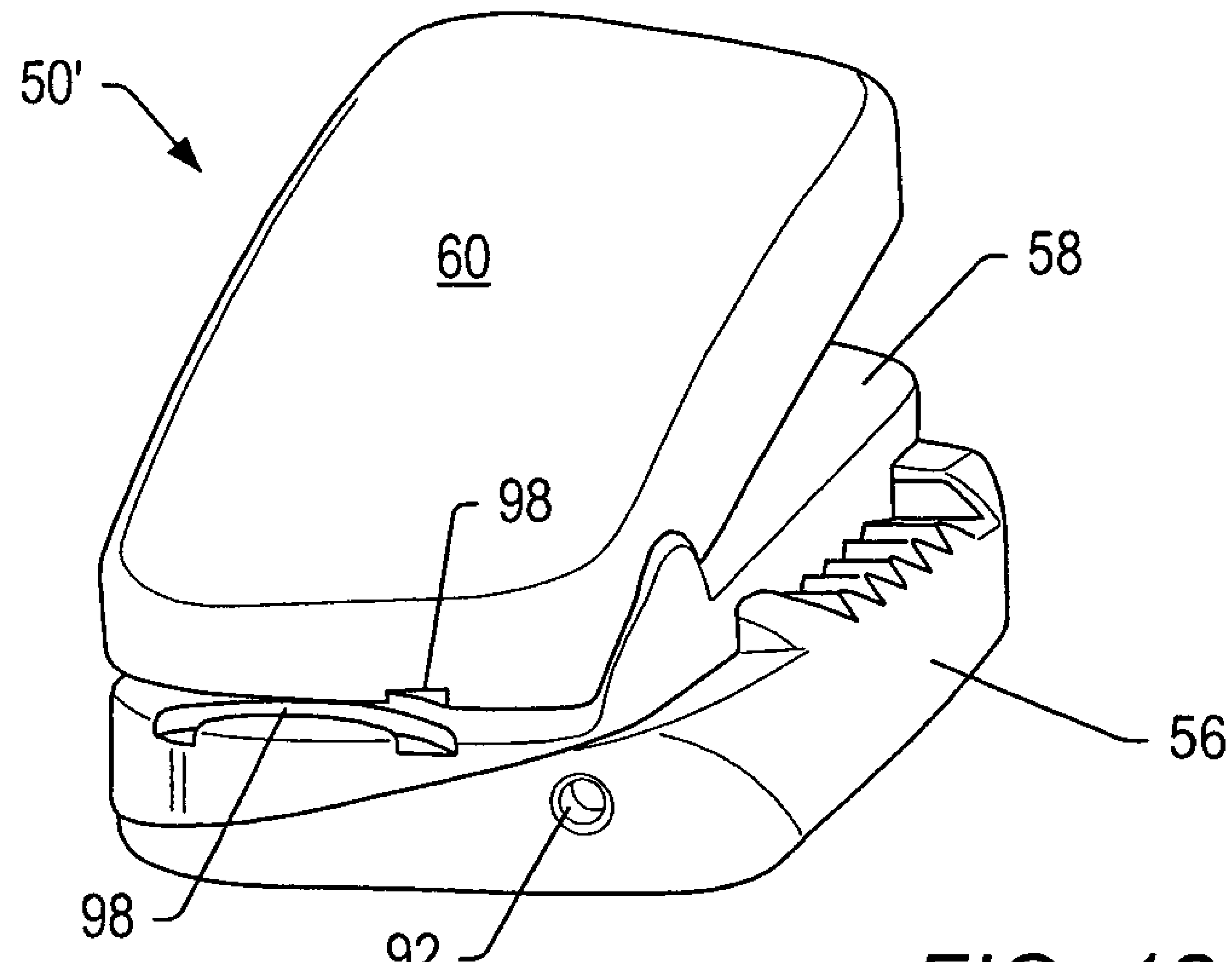


FIG. 13

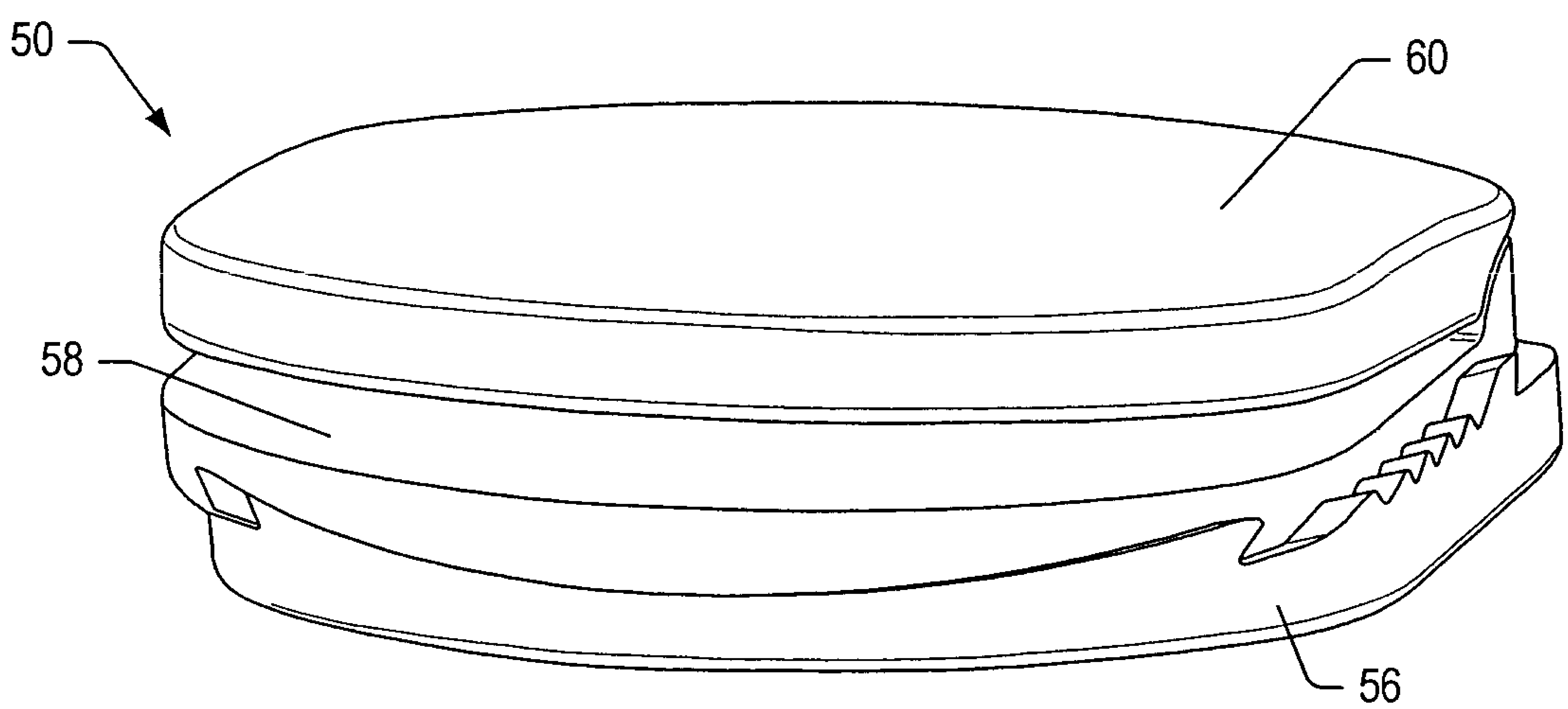
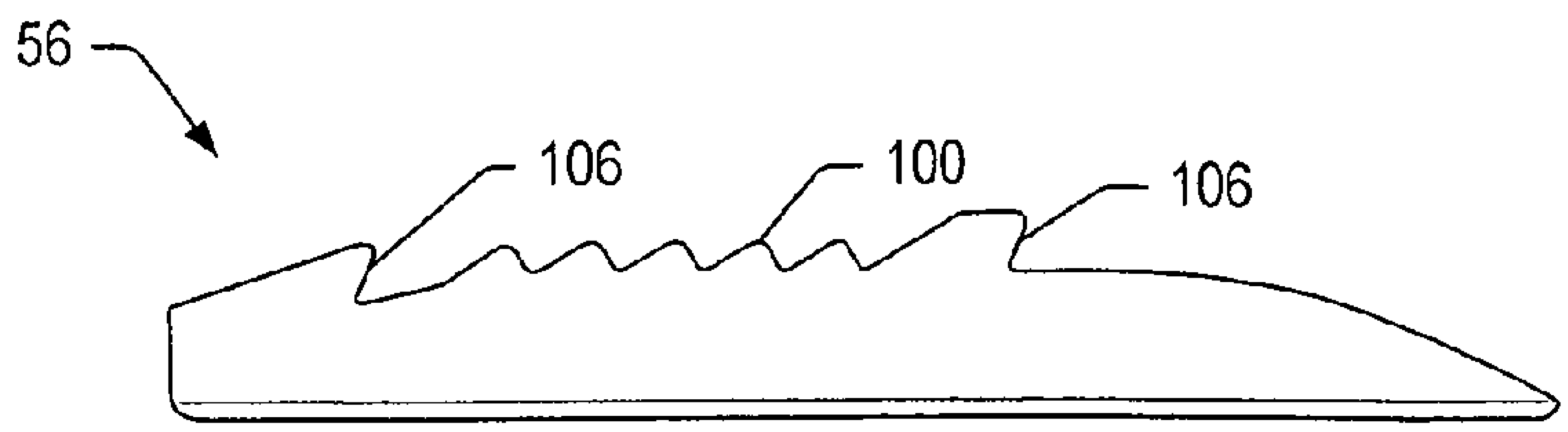


FIG. 14



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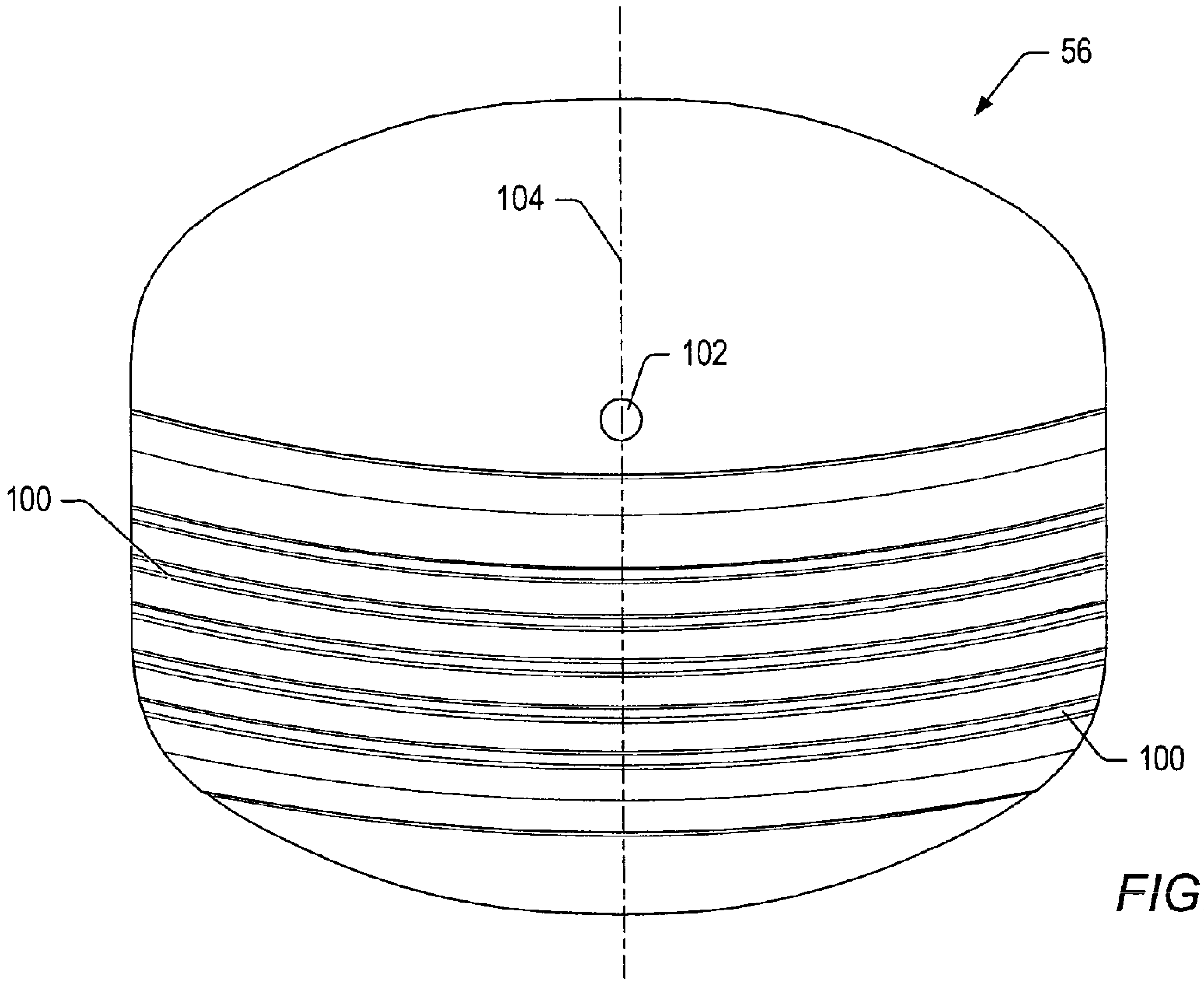


FIG. 16

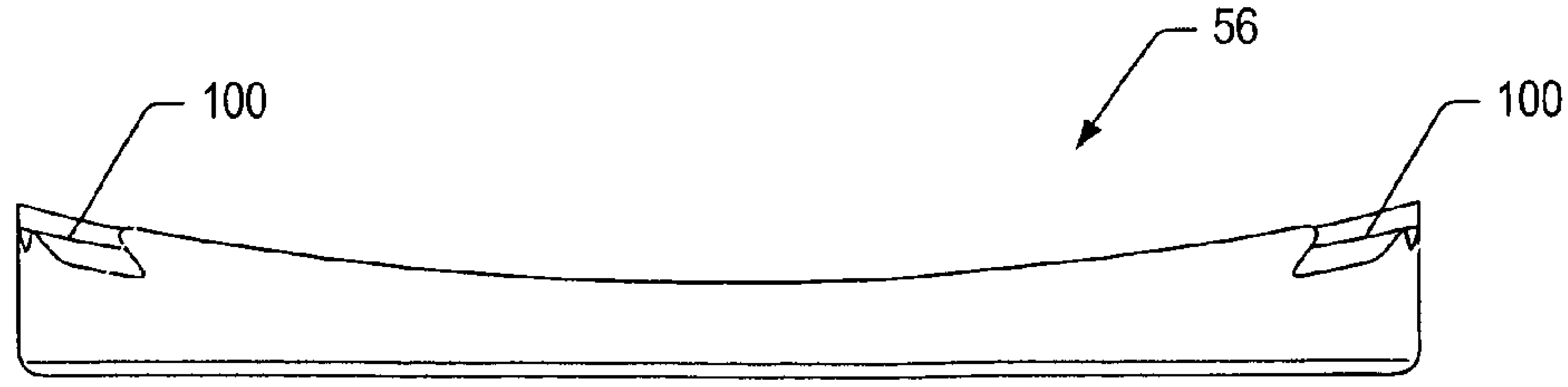
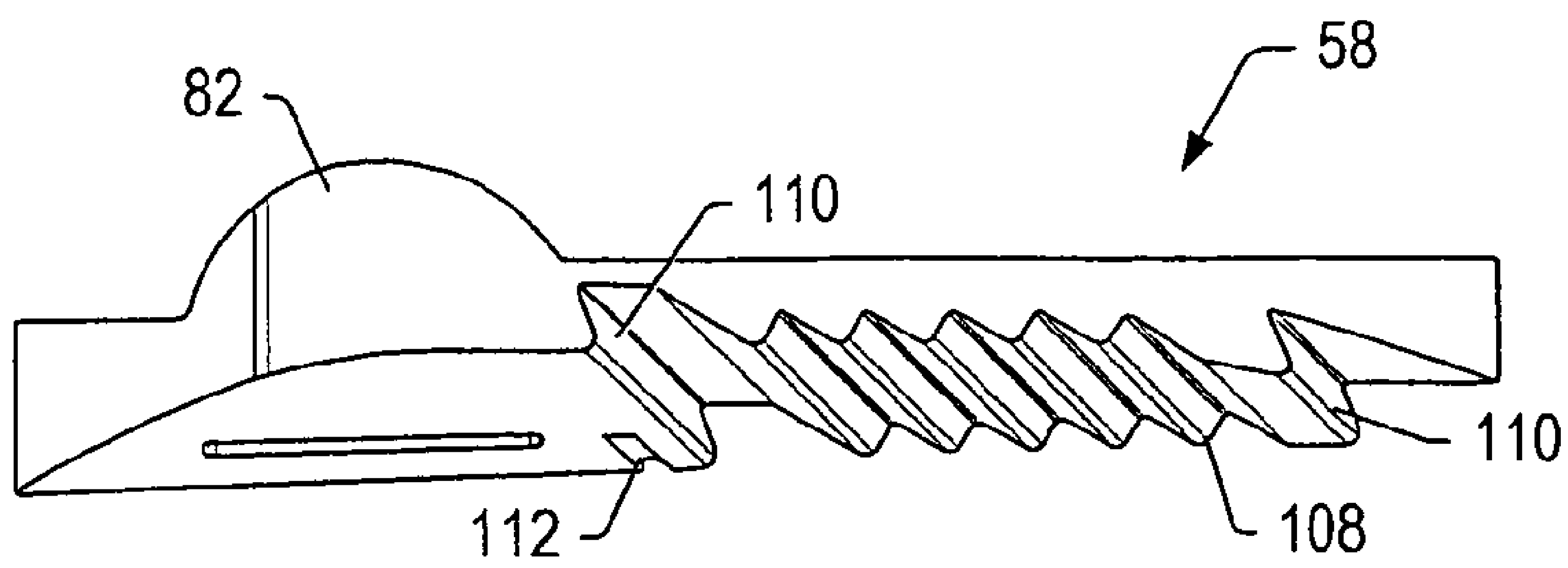


FIG. 17



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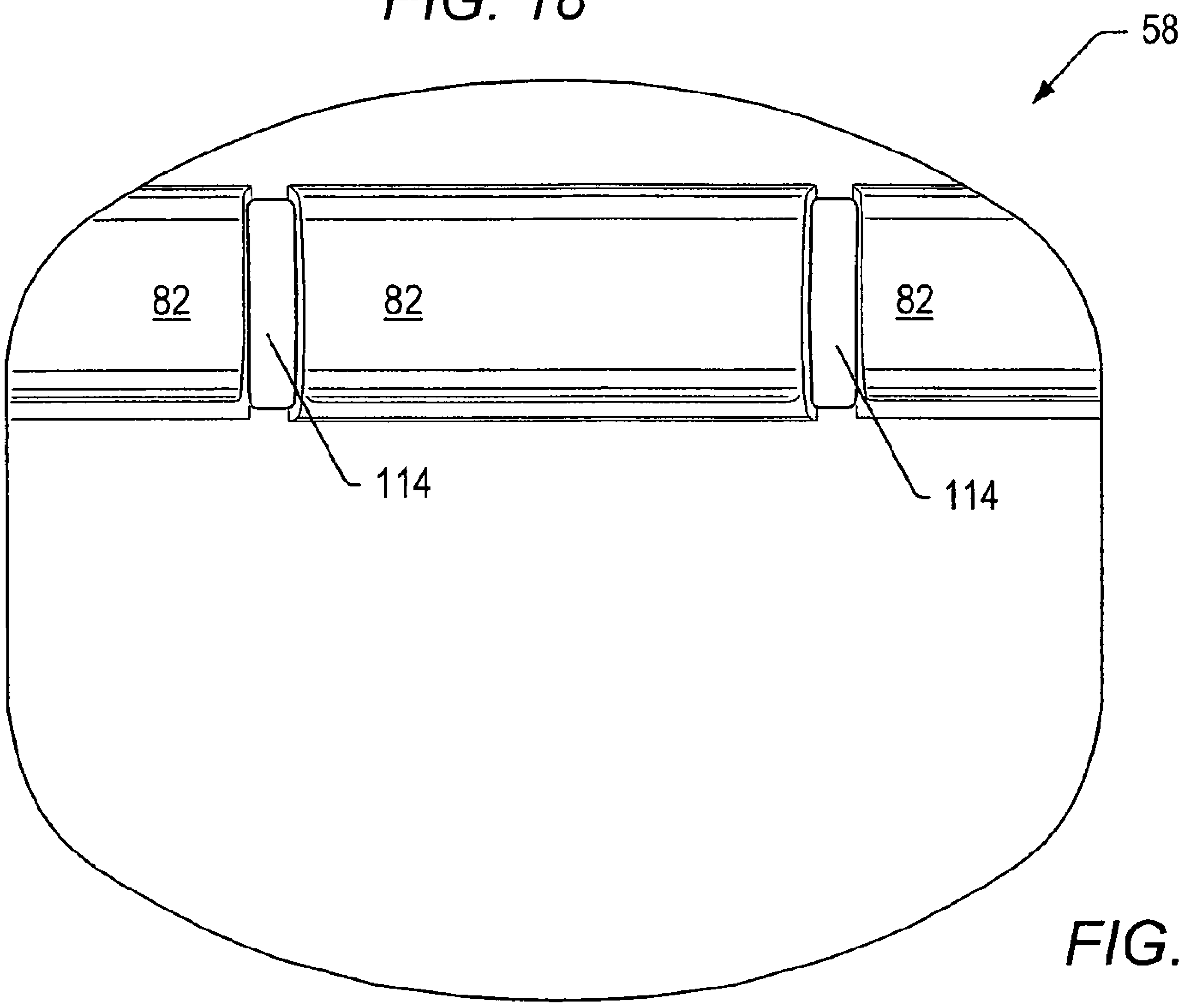


FIG. 19

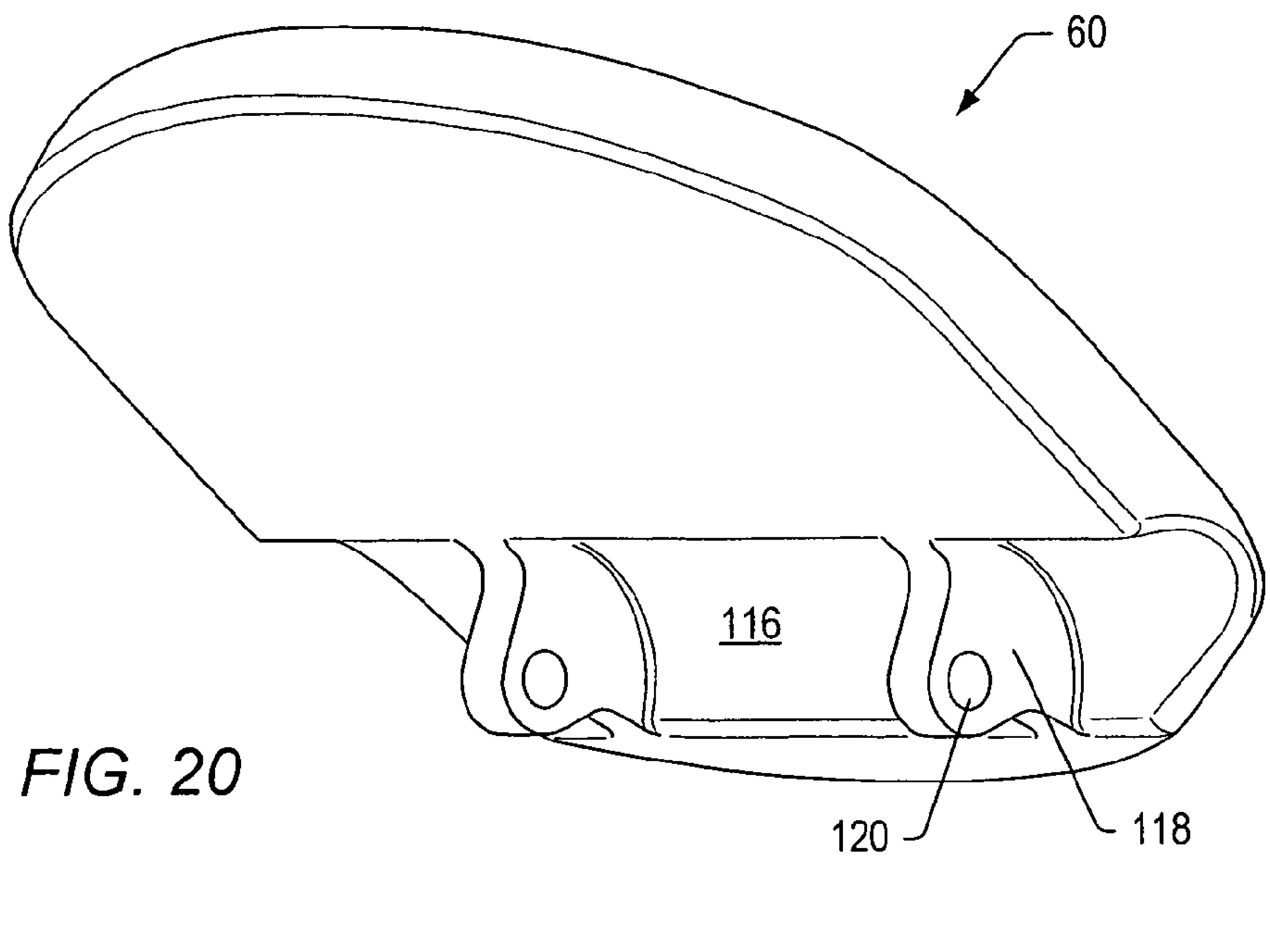


FIG. 20

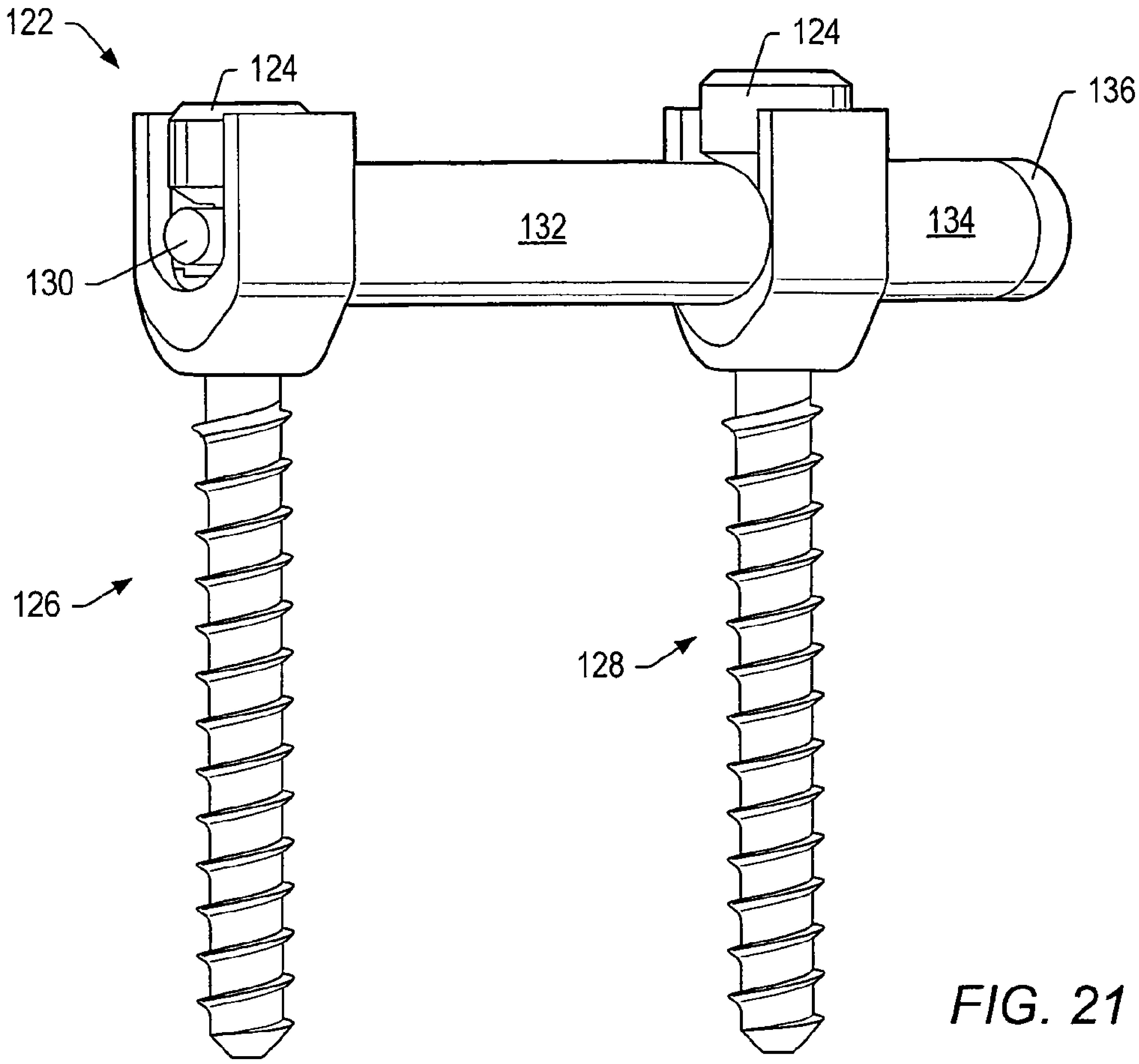


FIG. 21

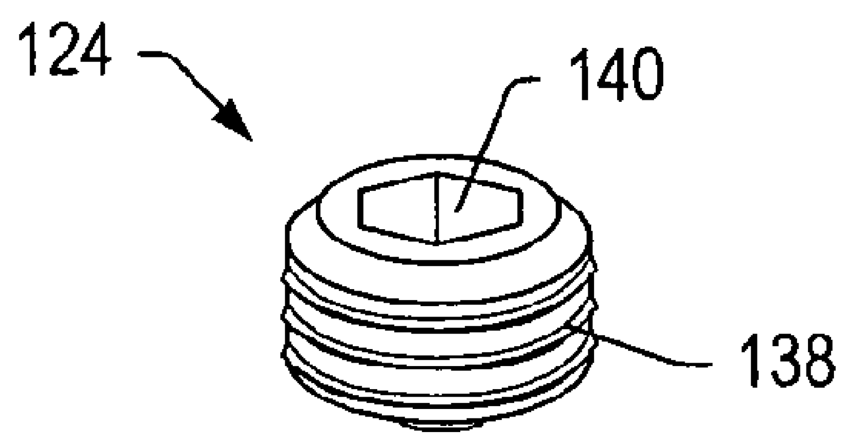


FIG. 22

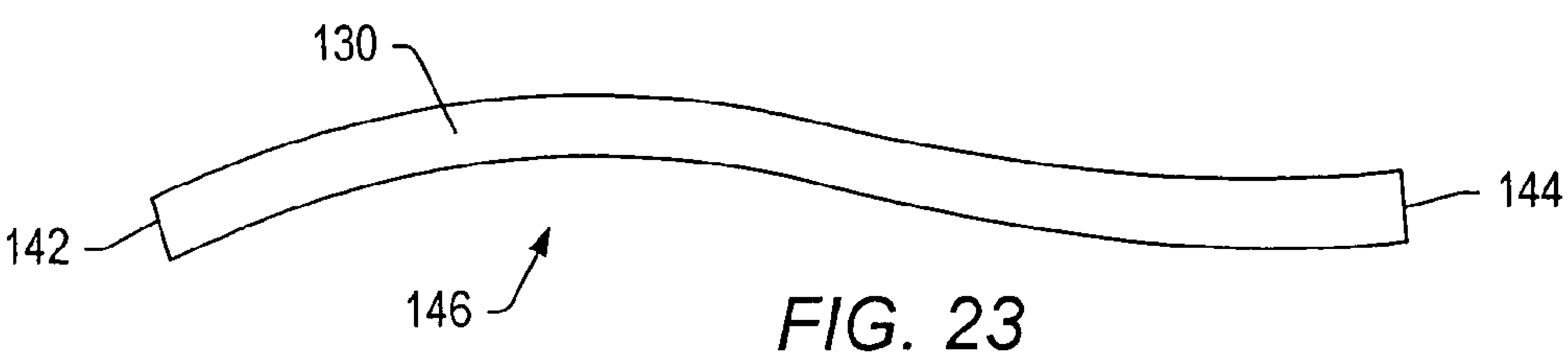
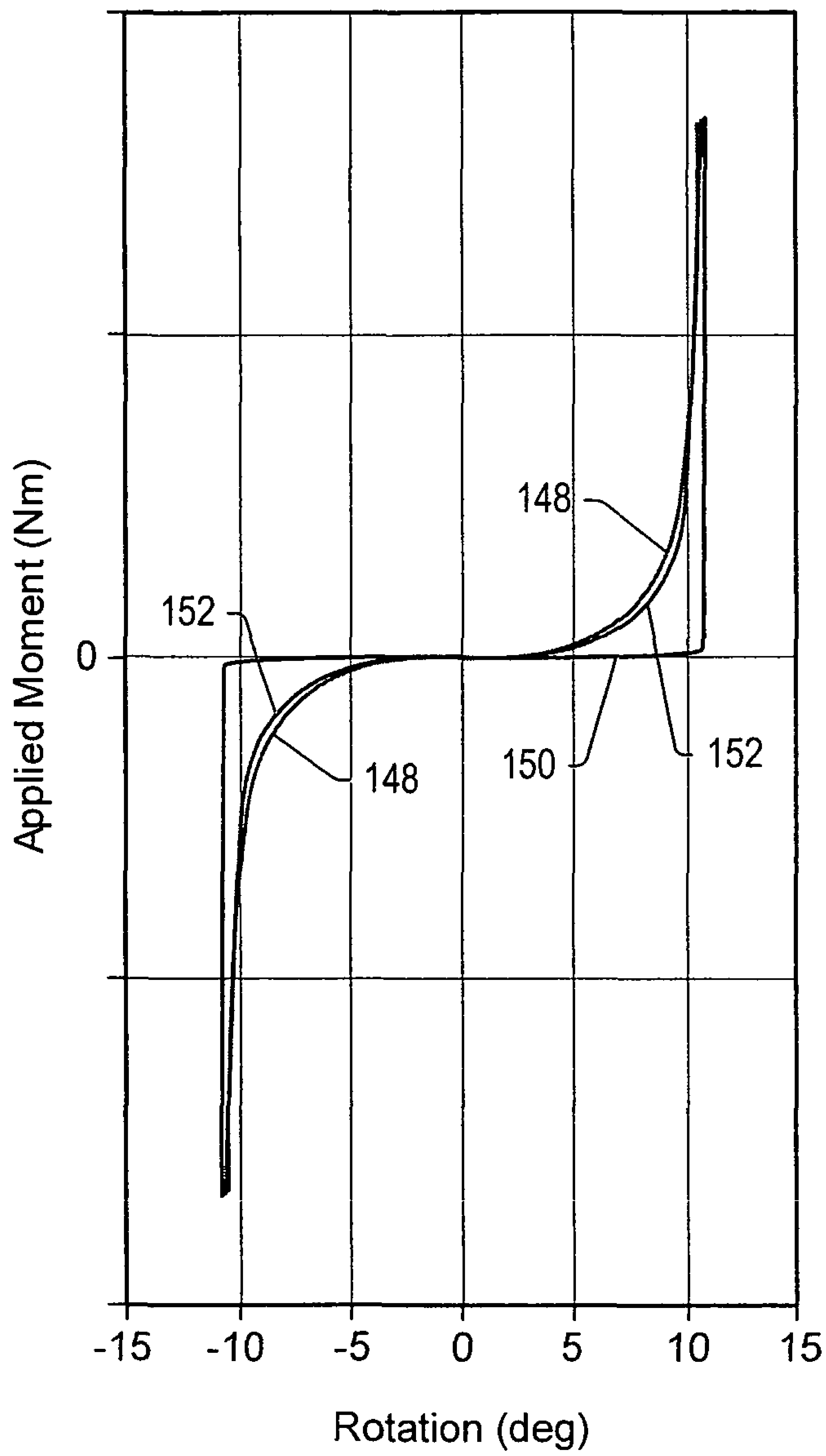


FIG. 23



Applied Moment (Nm)
0
152
148
148
150
152
-15
-10
-5
0
5
10
15
Rotation (deg)

FIG. 24

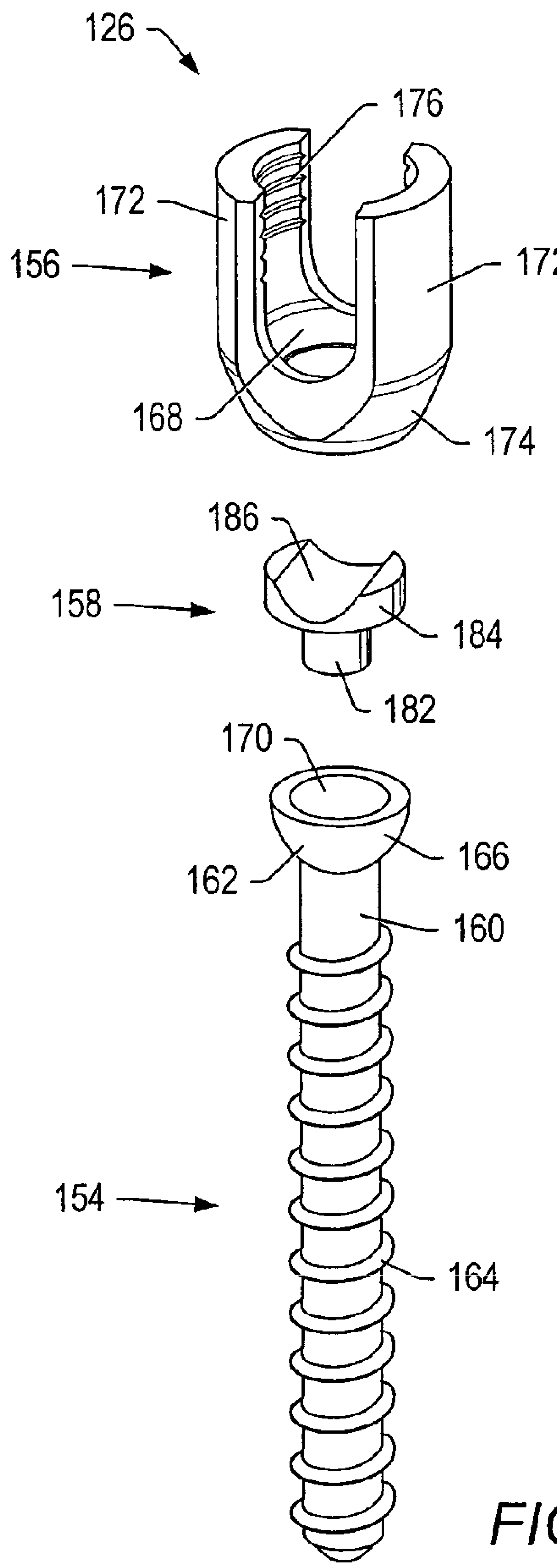


FIG. 25

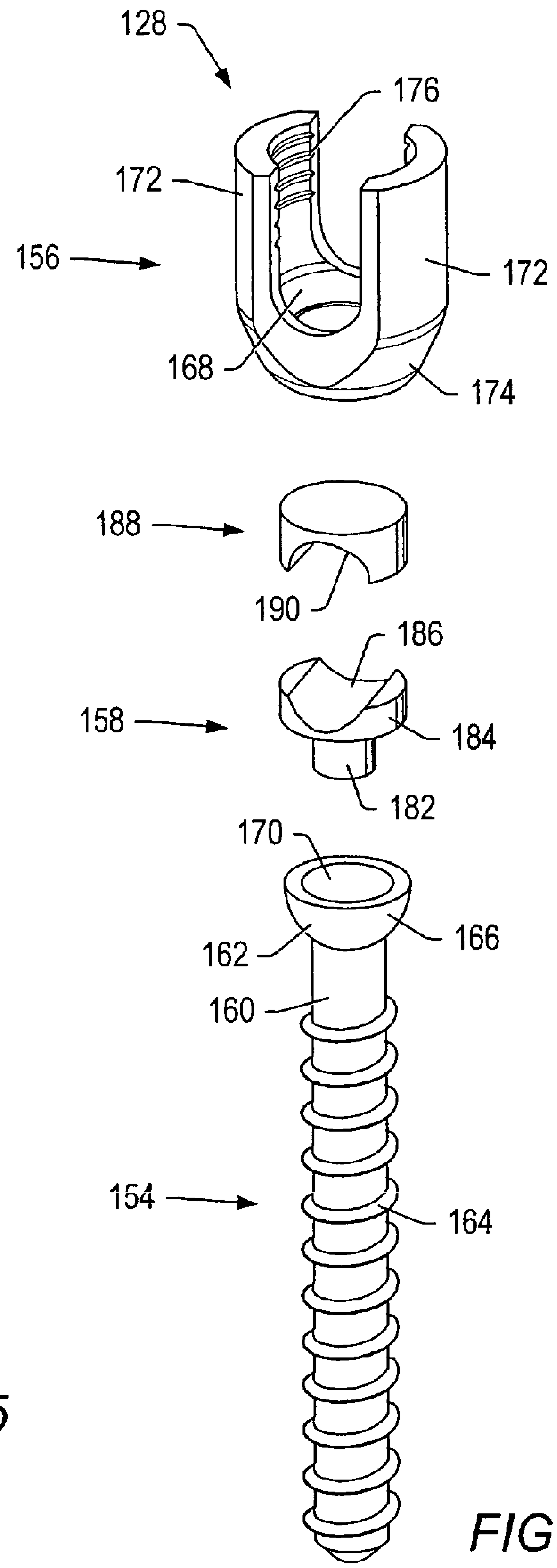


FIG. 26

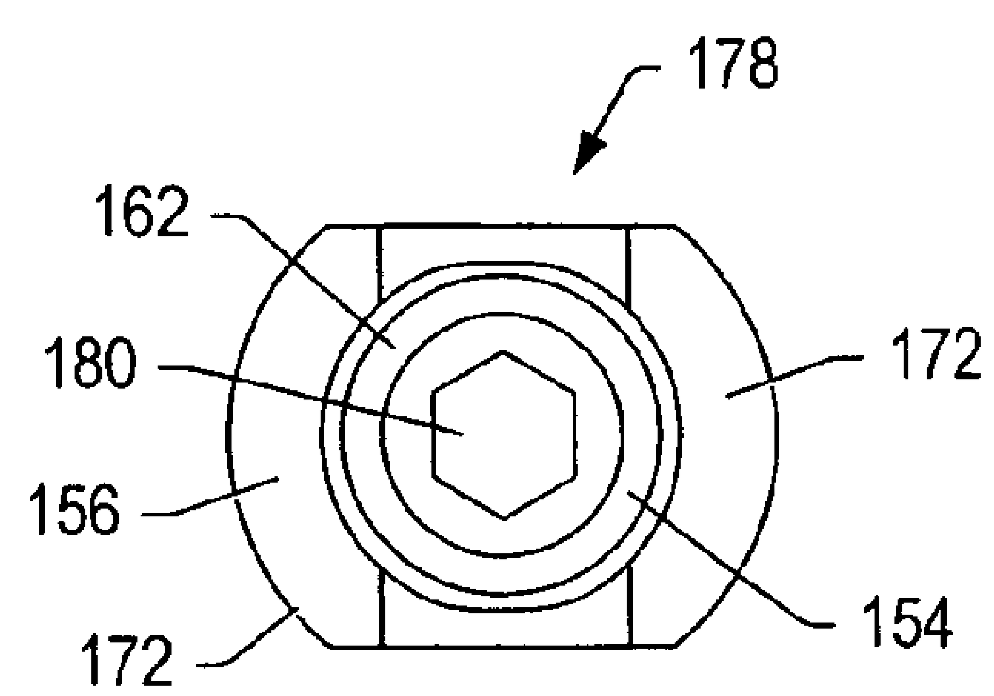


FIG. 27

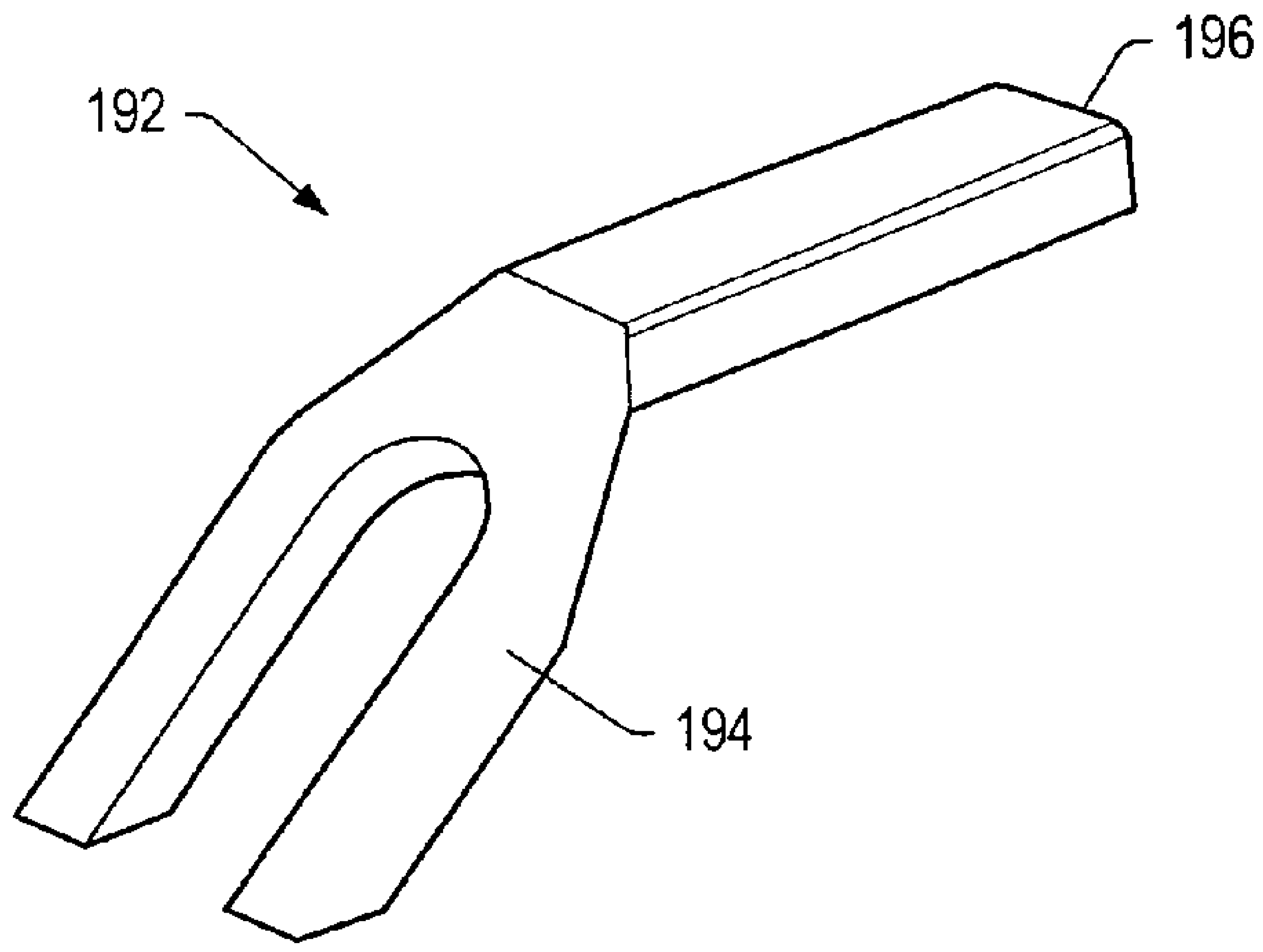
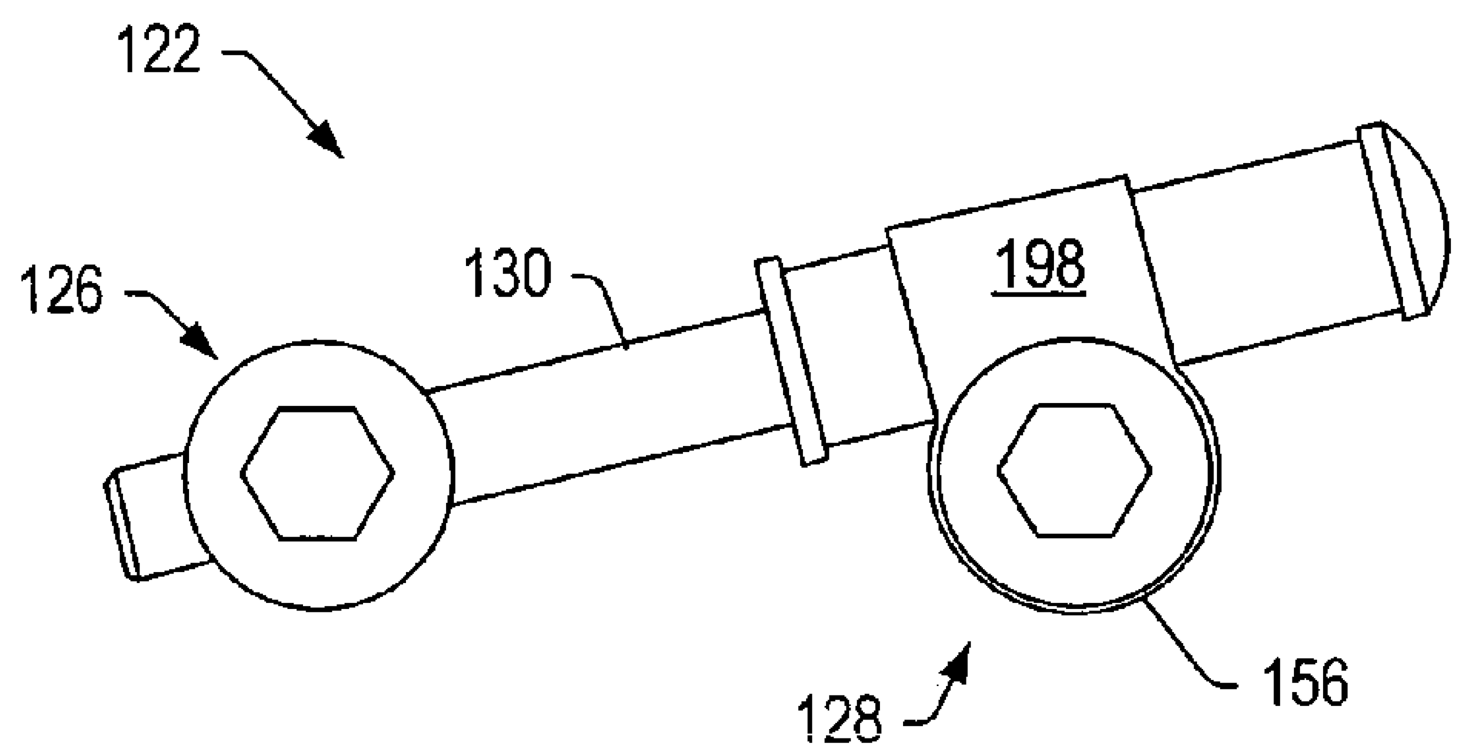


FIG. 28



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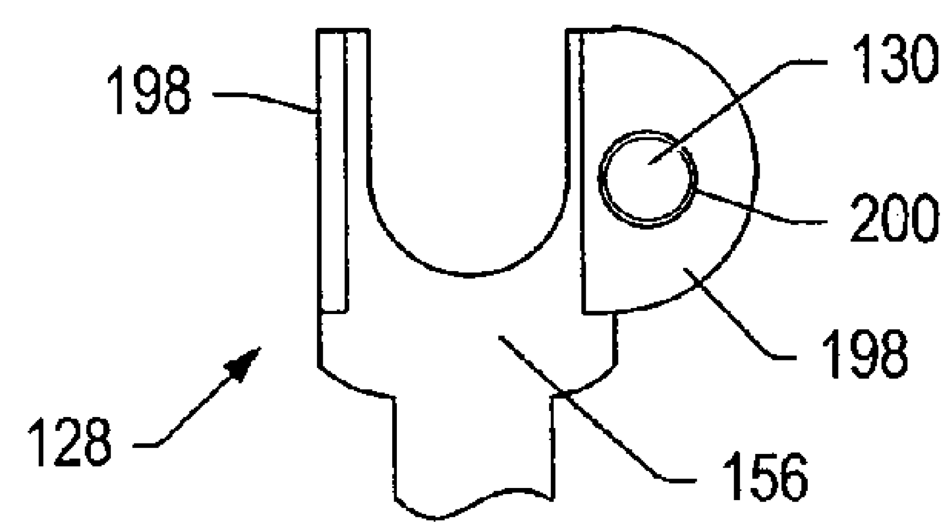


FIG. 30

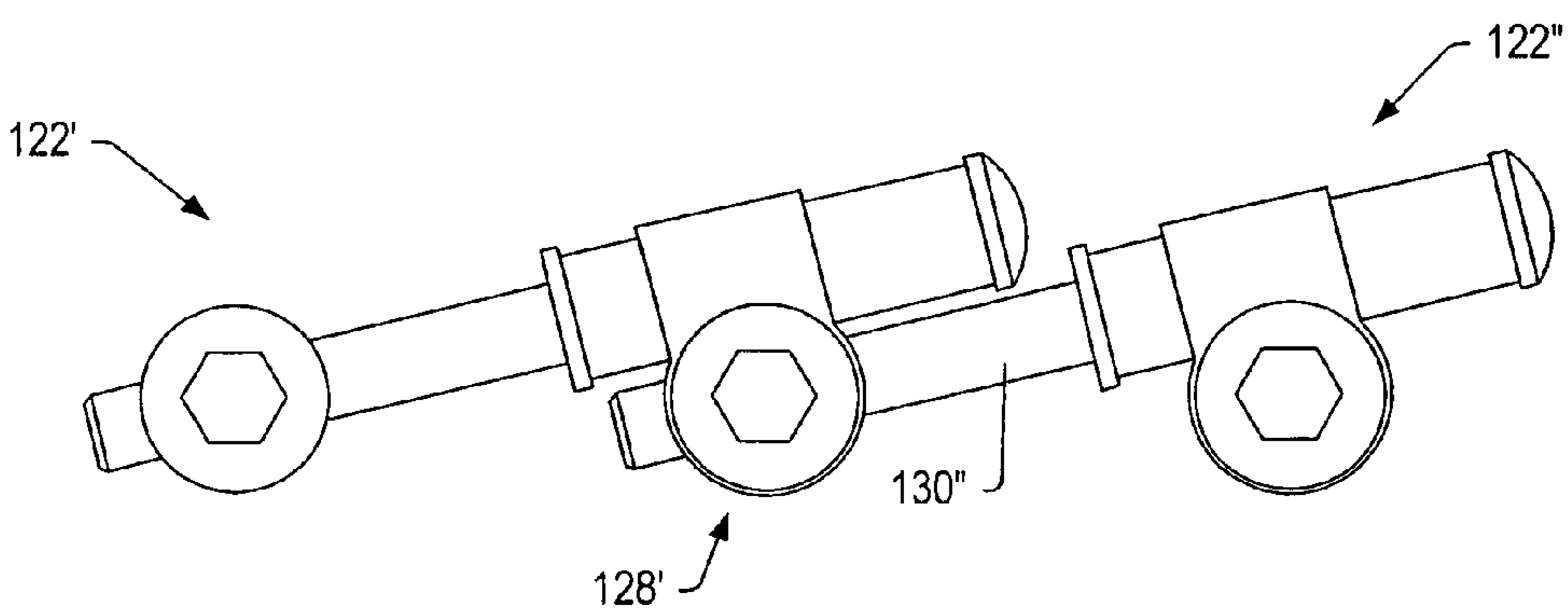
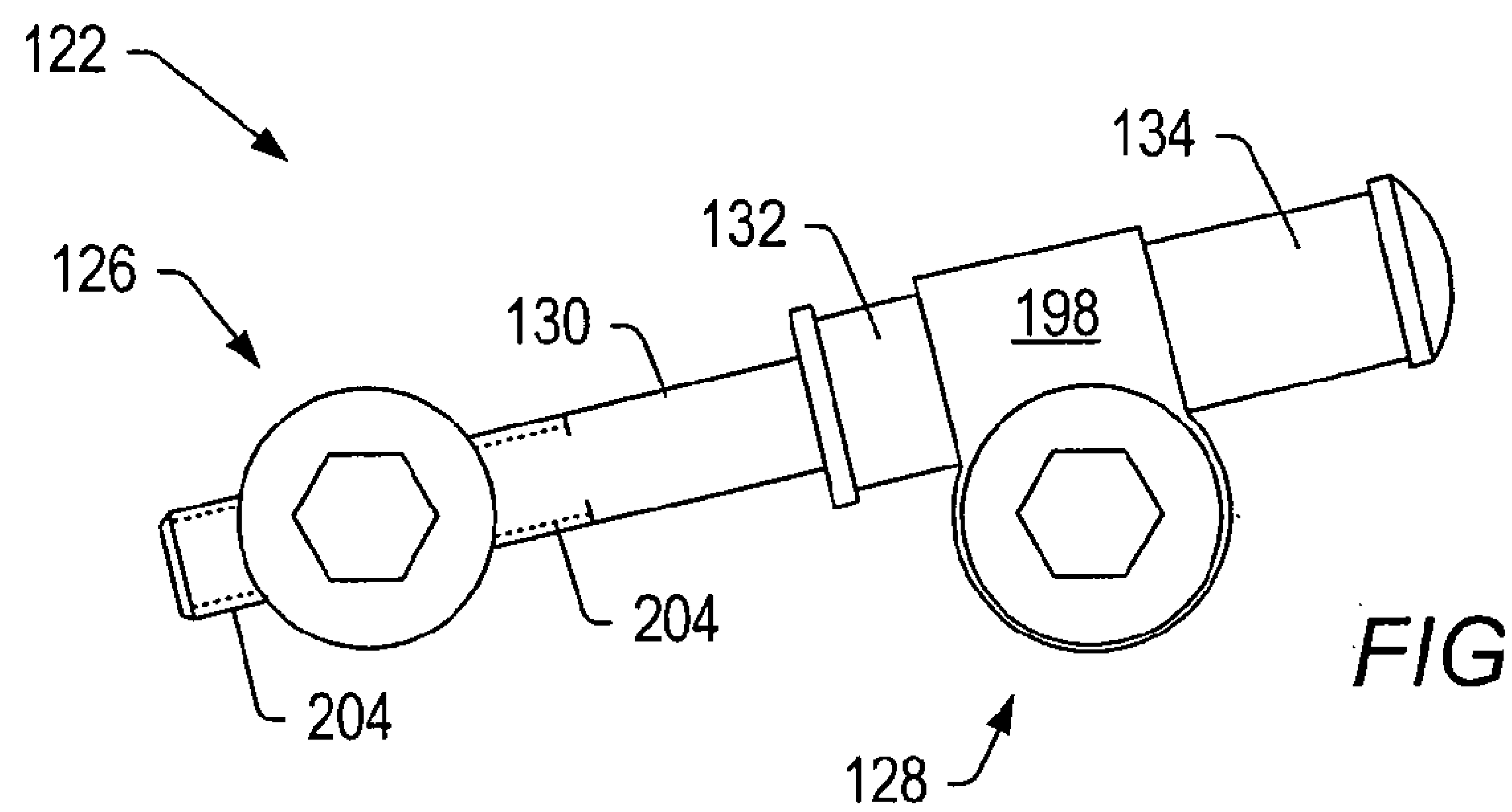


FIG. 31



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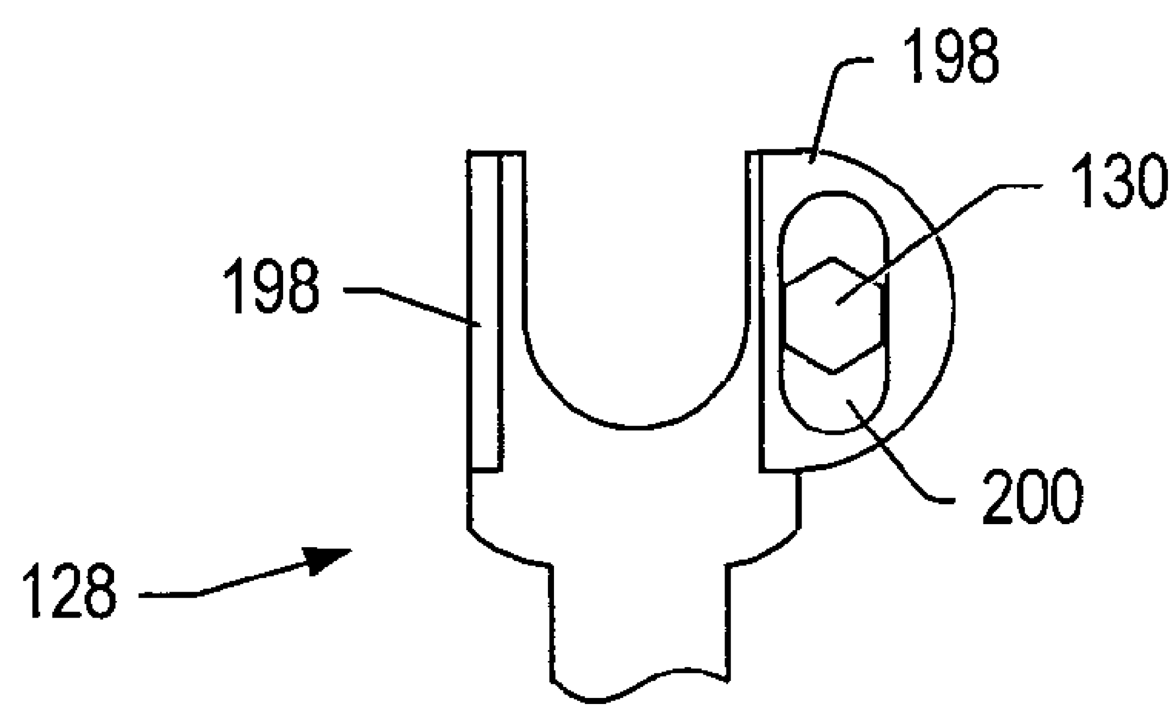


FIG. 33

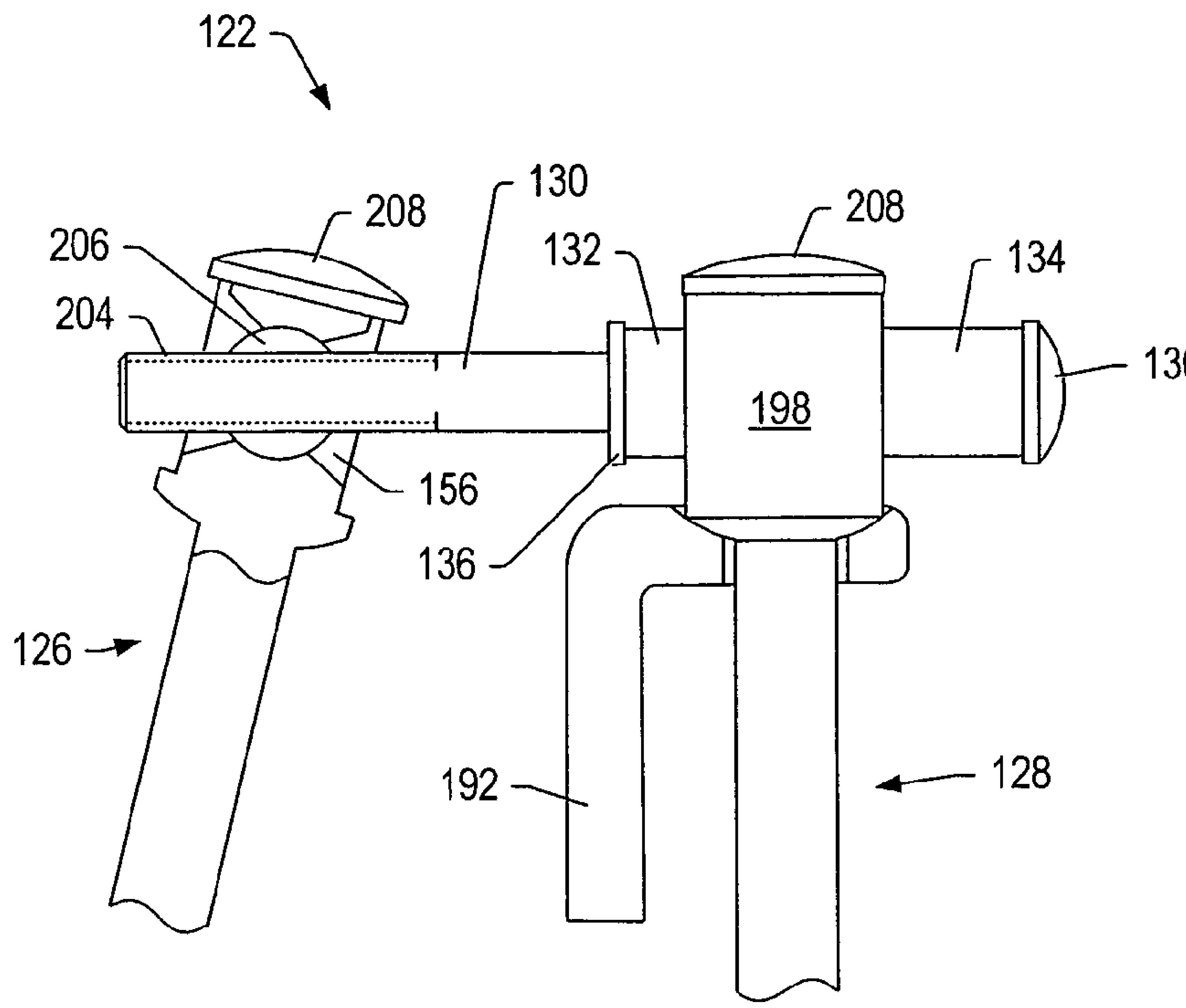


FIG. 34

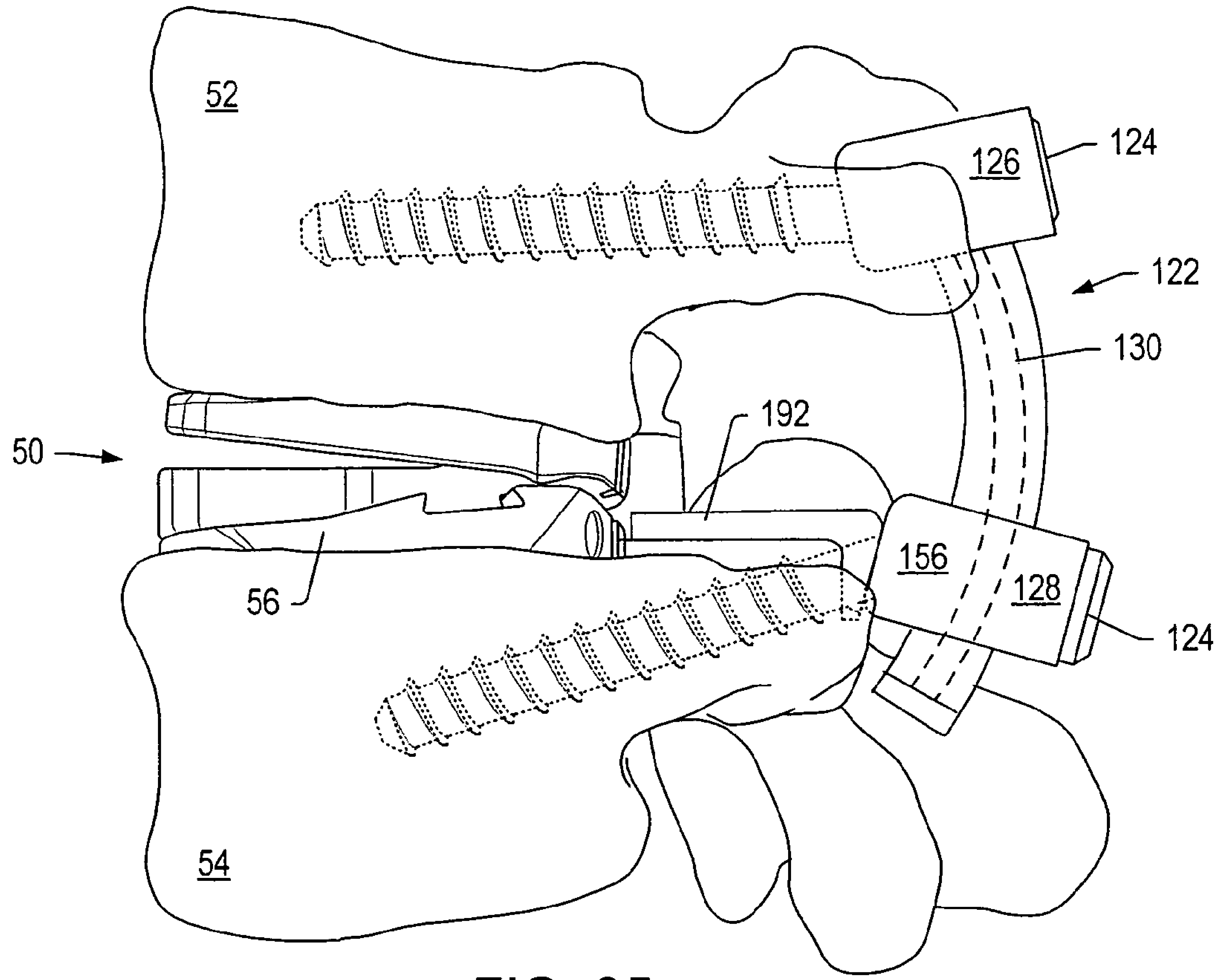
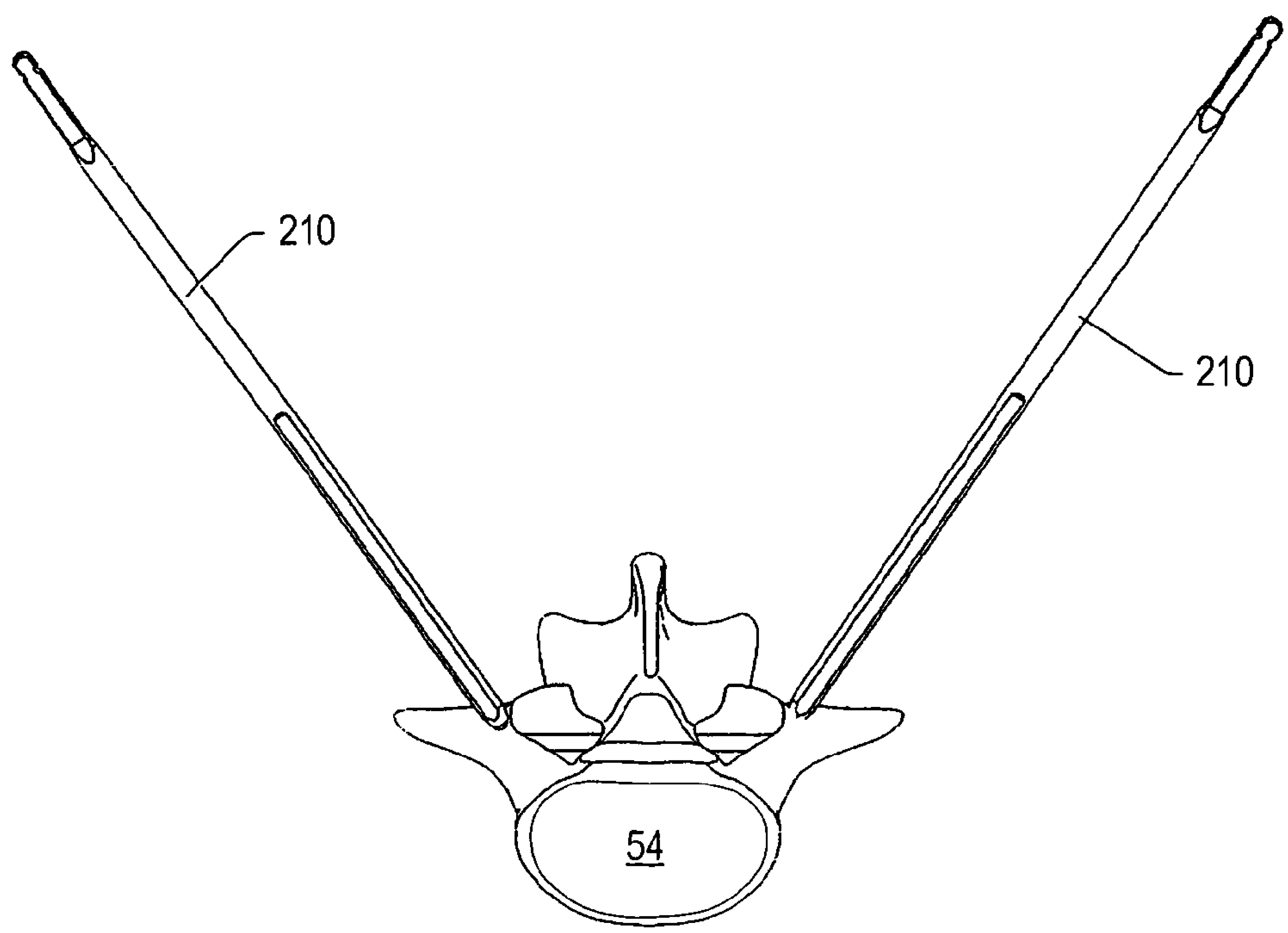


FIG. 35



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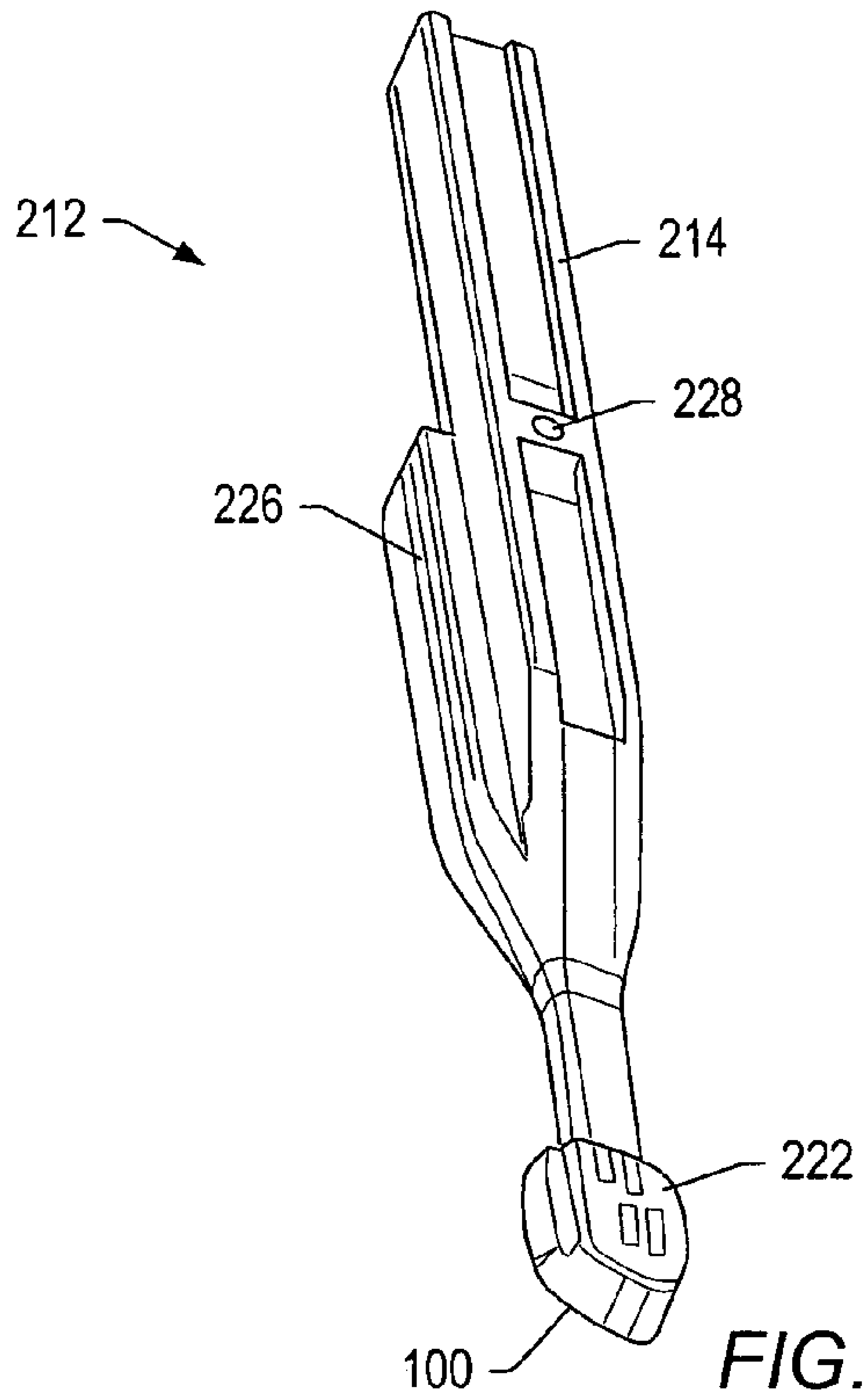


FIG. 37

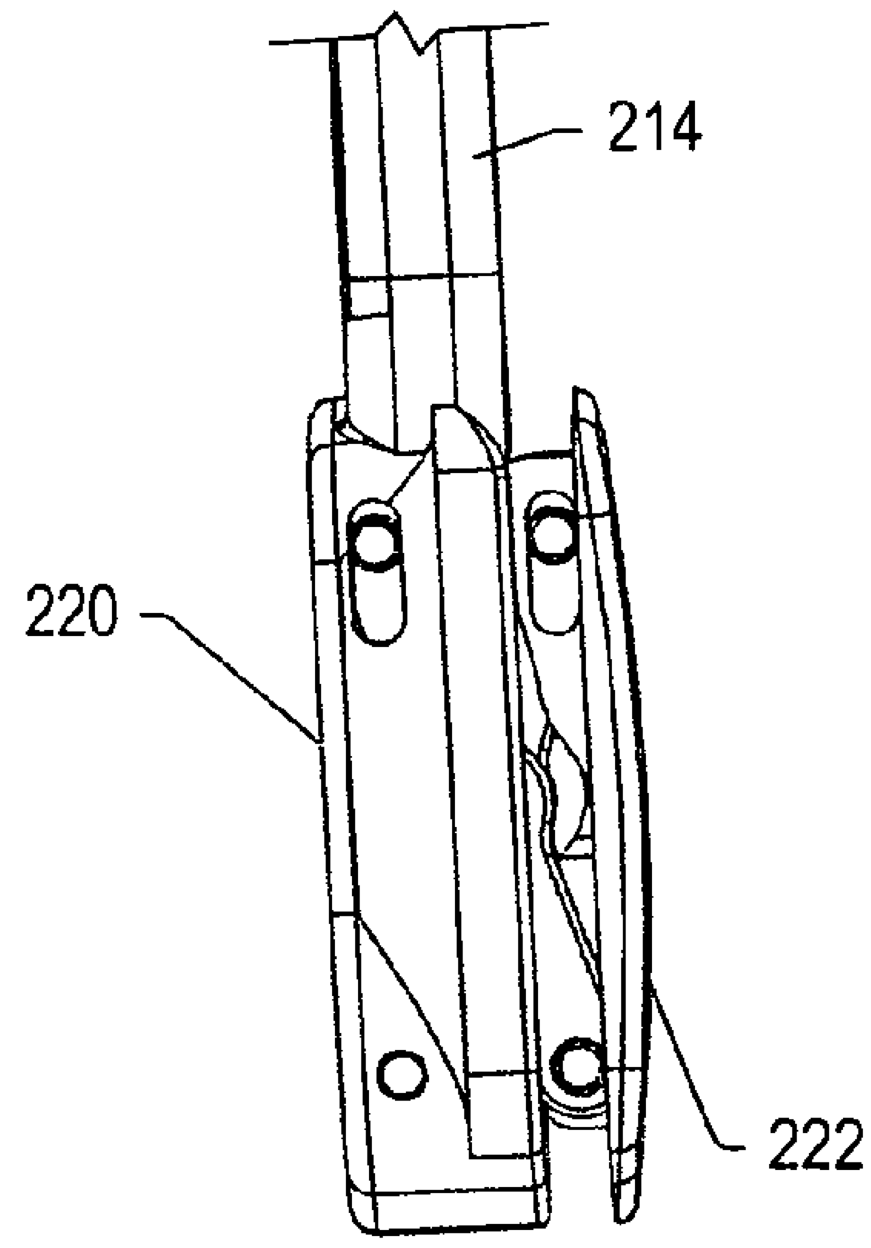


FIG. 38

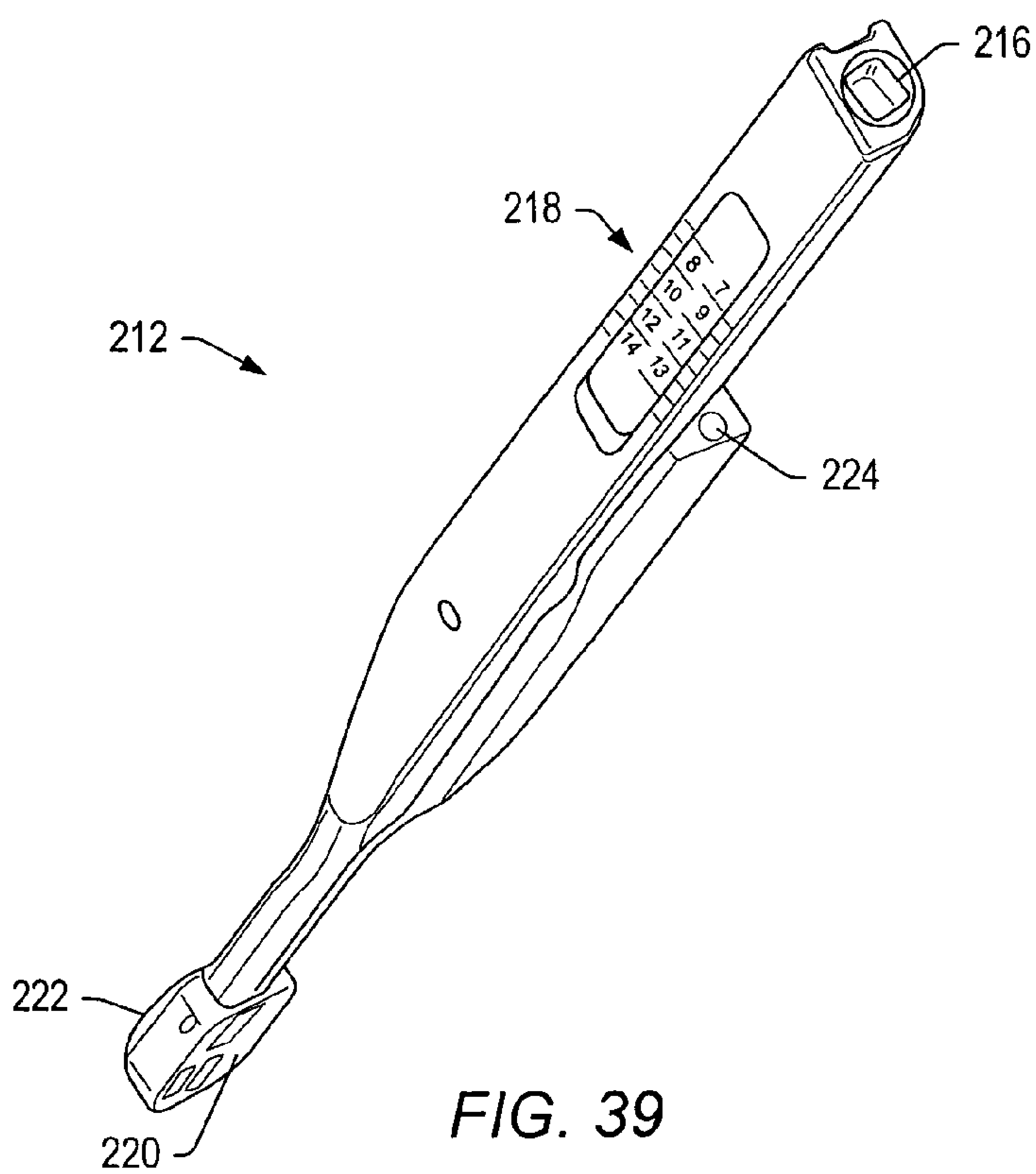


FIG. 39

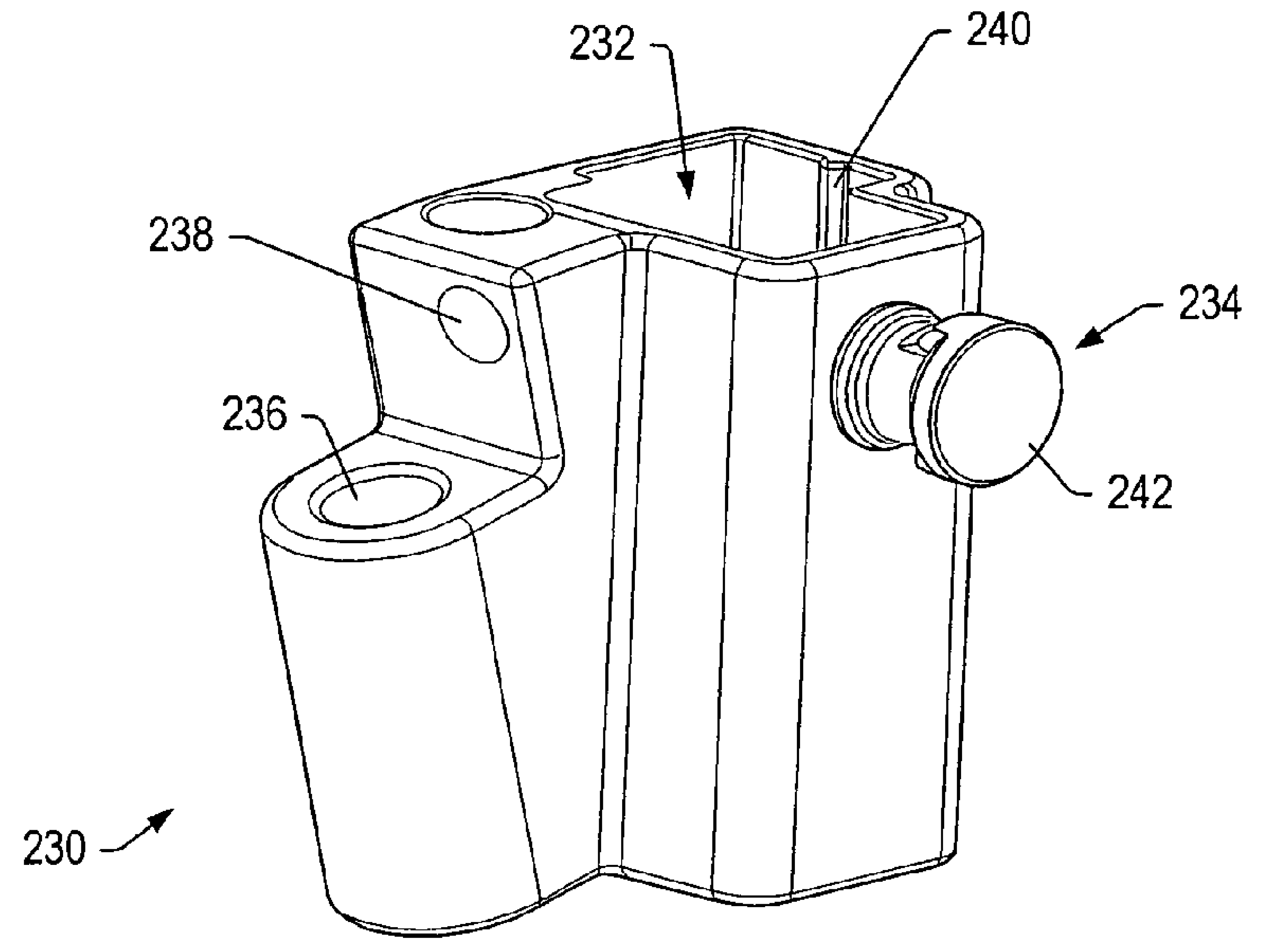


FIG. 40

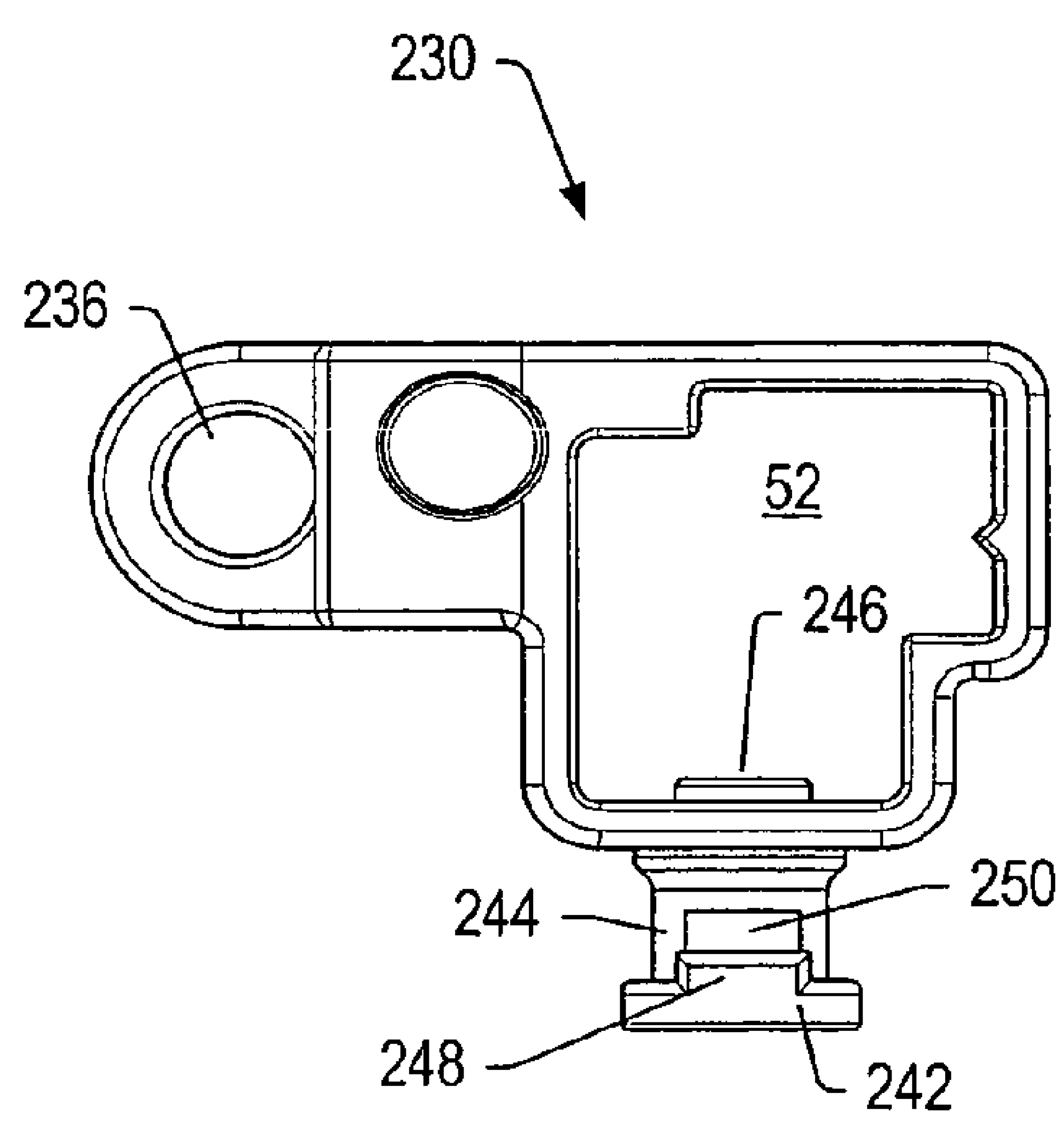


FIG. 41

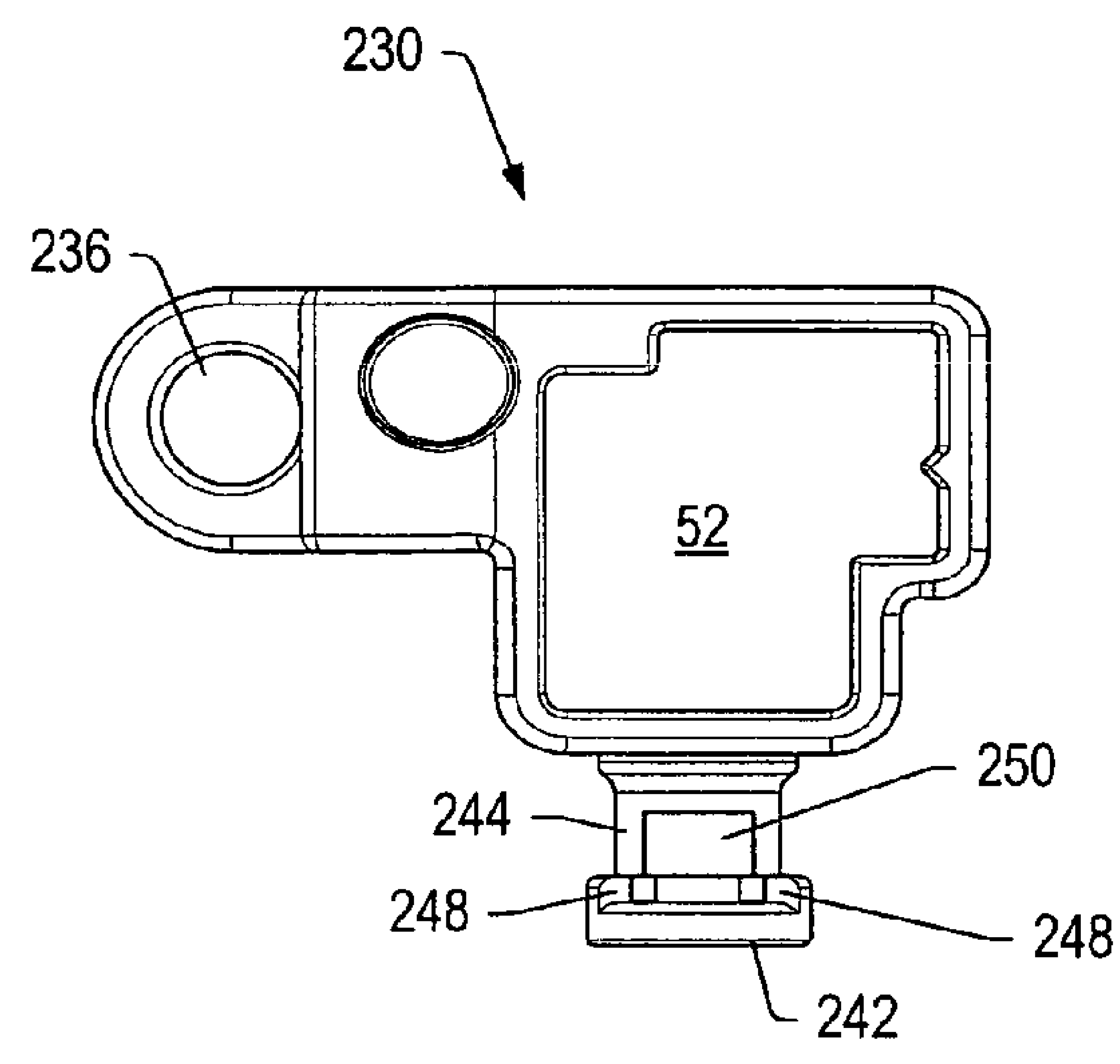


FIG. 42

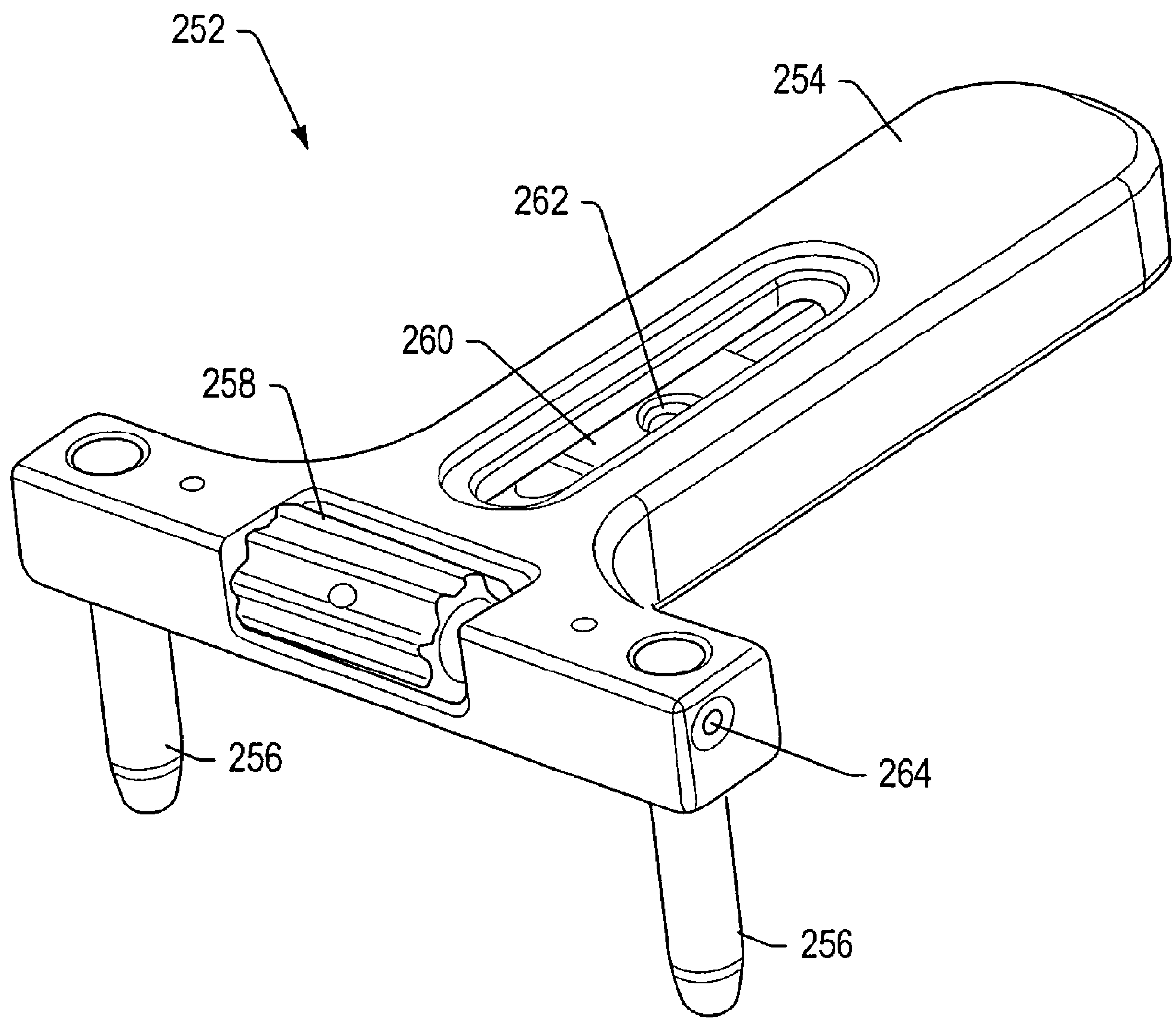


FIG. 43

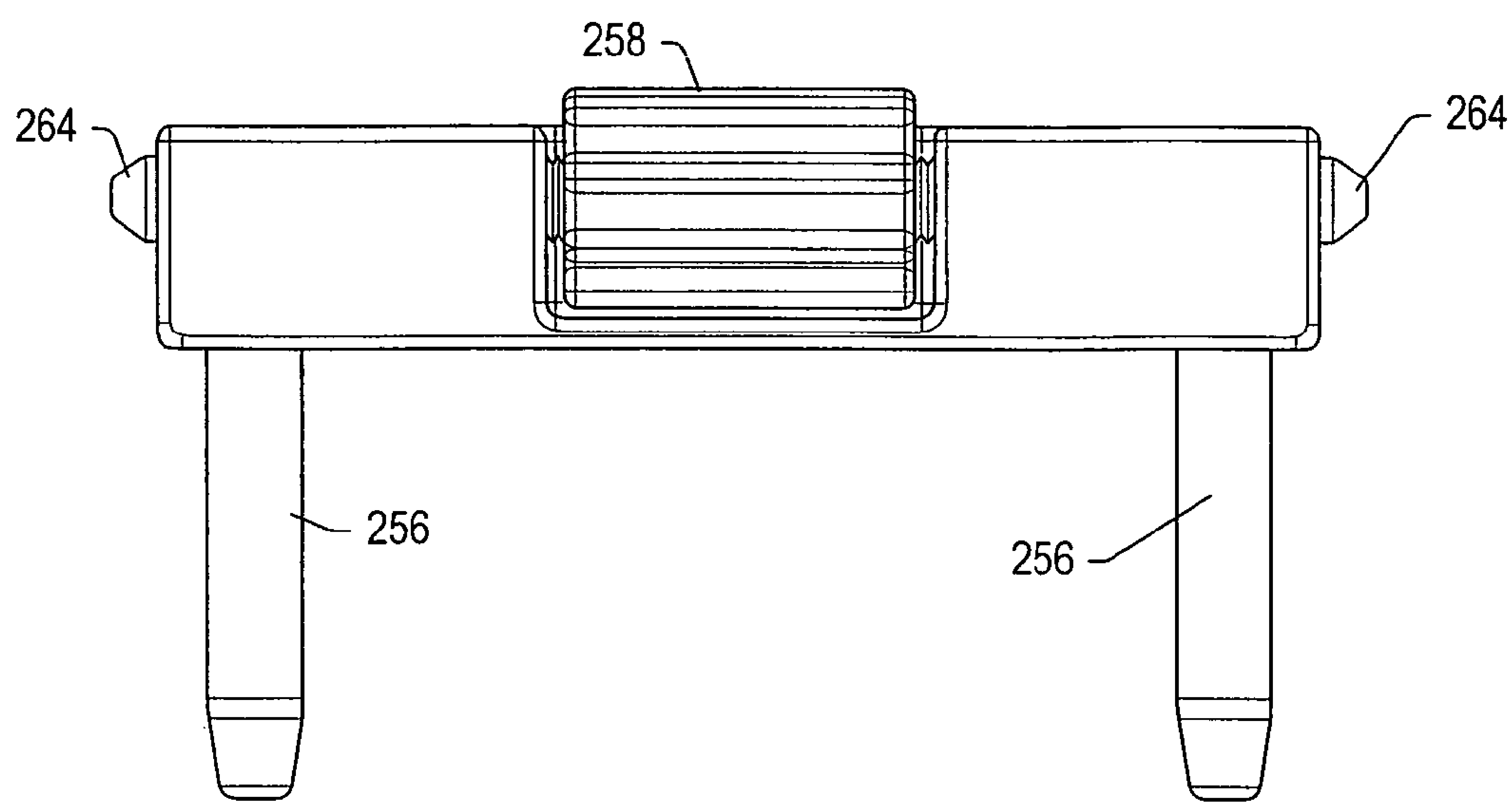


FIG. 44

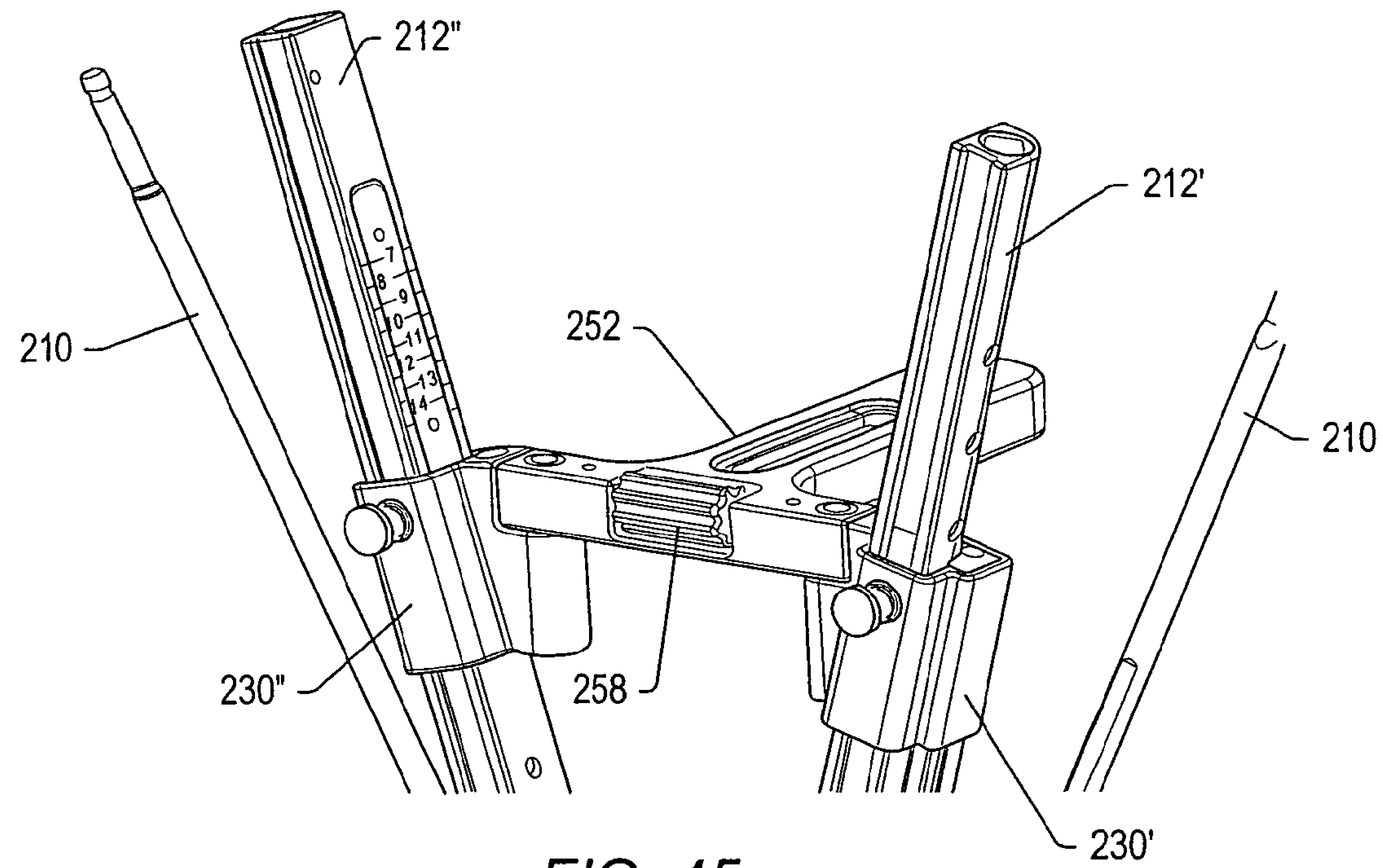

212"
212'
252
210
210
230"
258
230'

FIG. 45

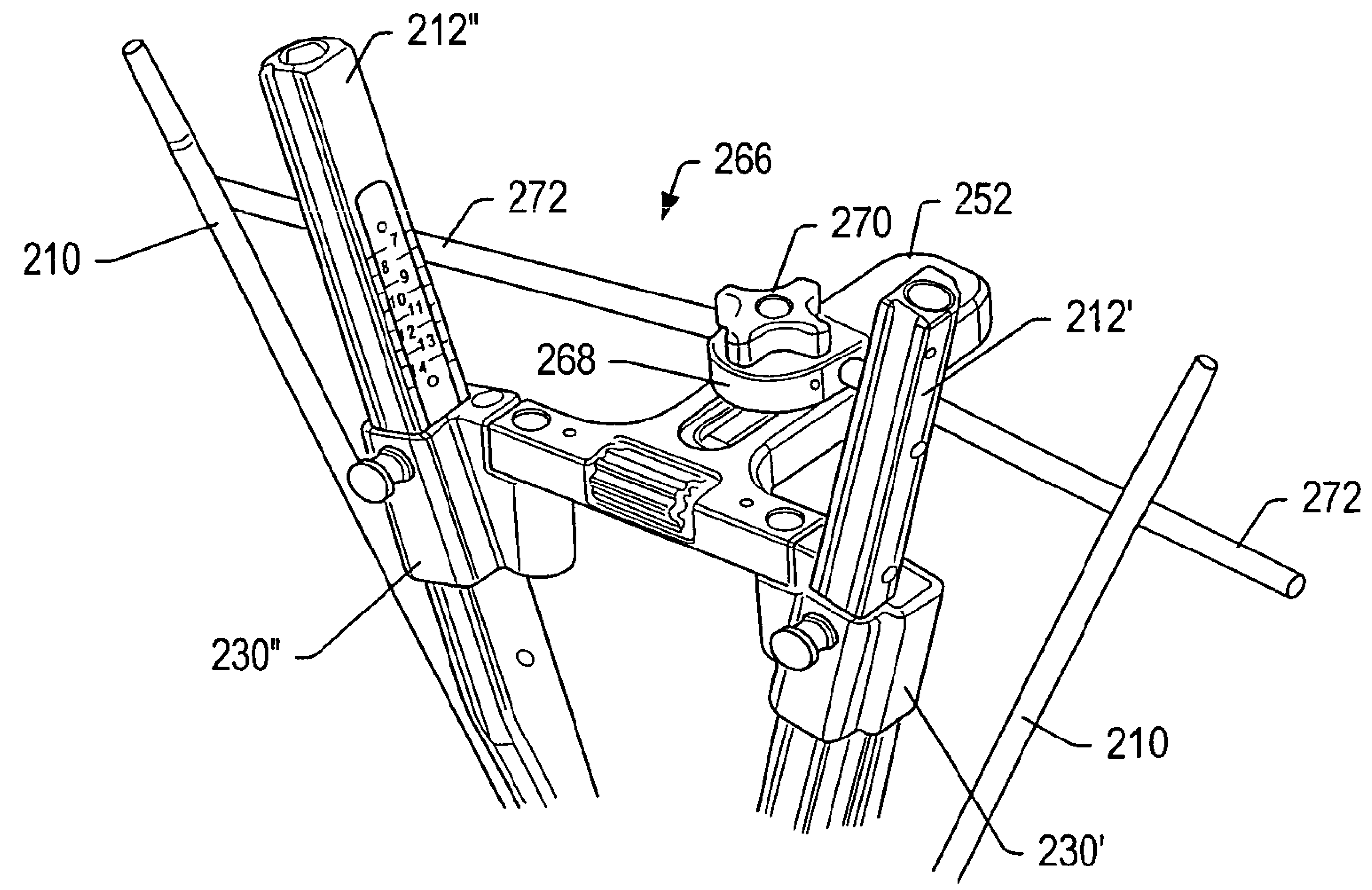

212"
266
272
252
270
210
268
212'
272
230"
210
230'

FIG. 46

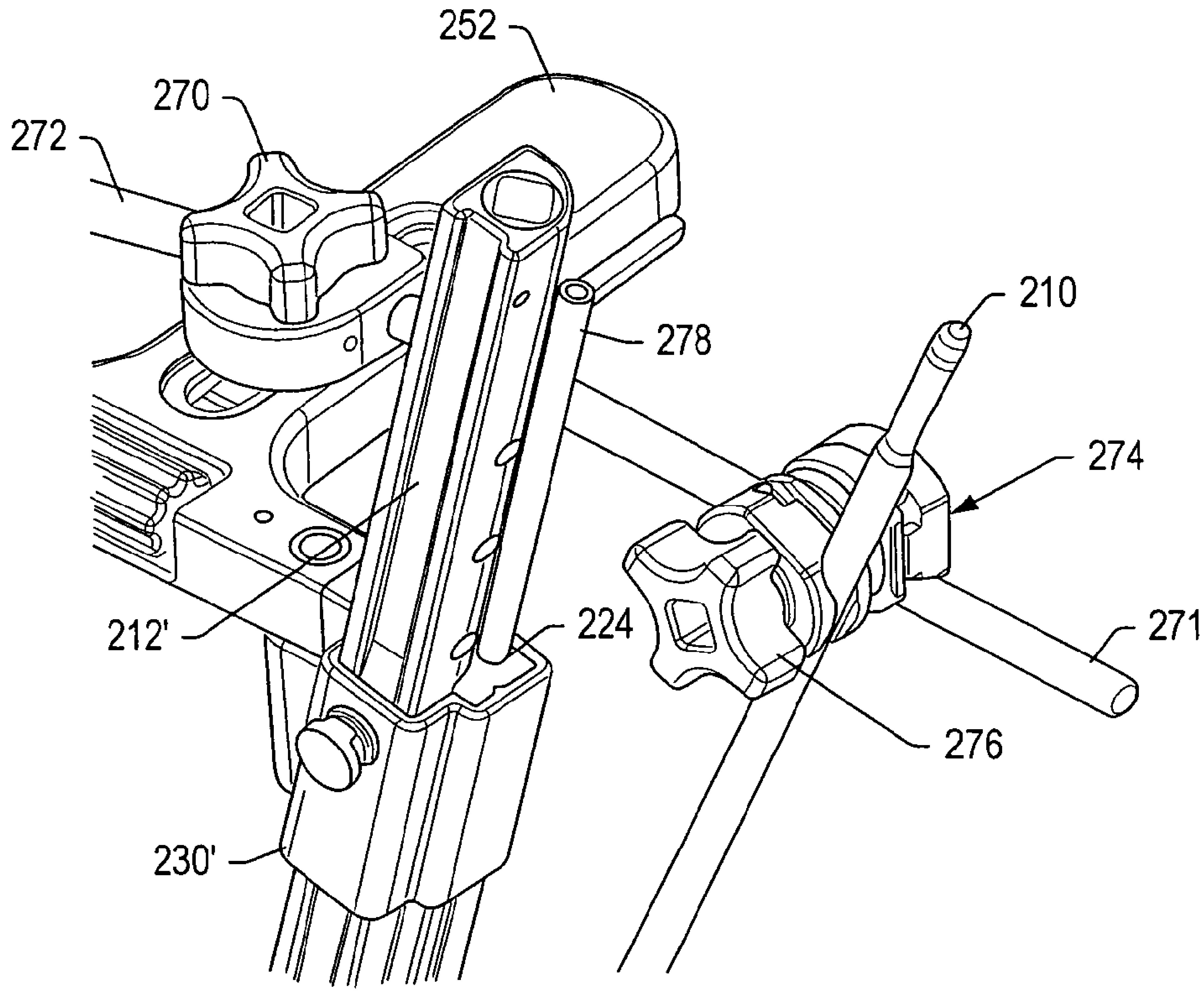

252
270
272
210
278
274
212'
224
271
276
230'

FIG. 47

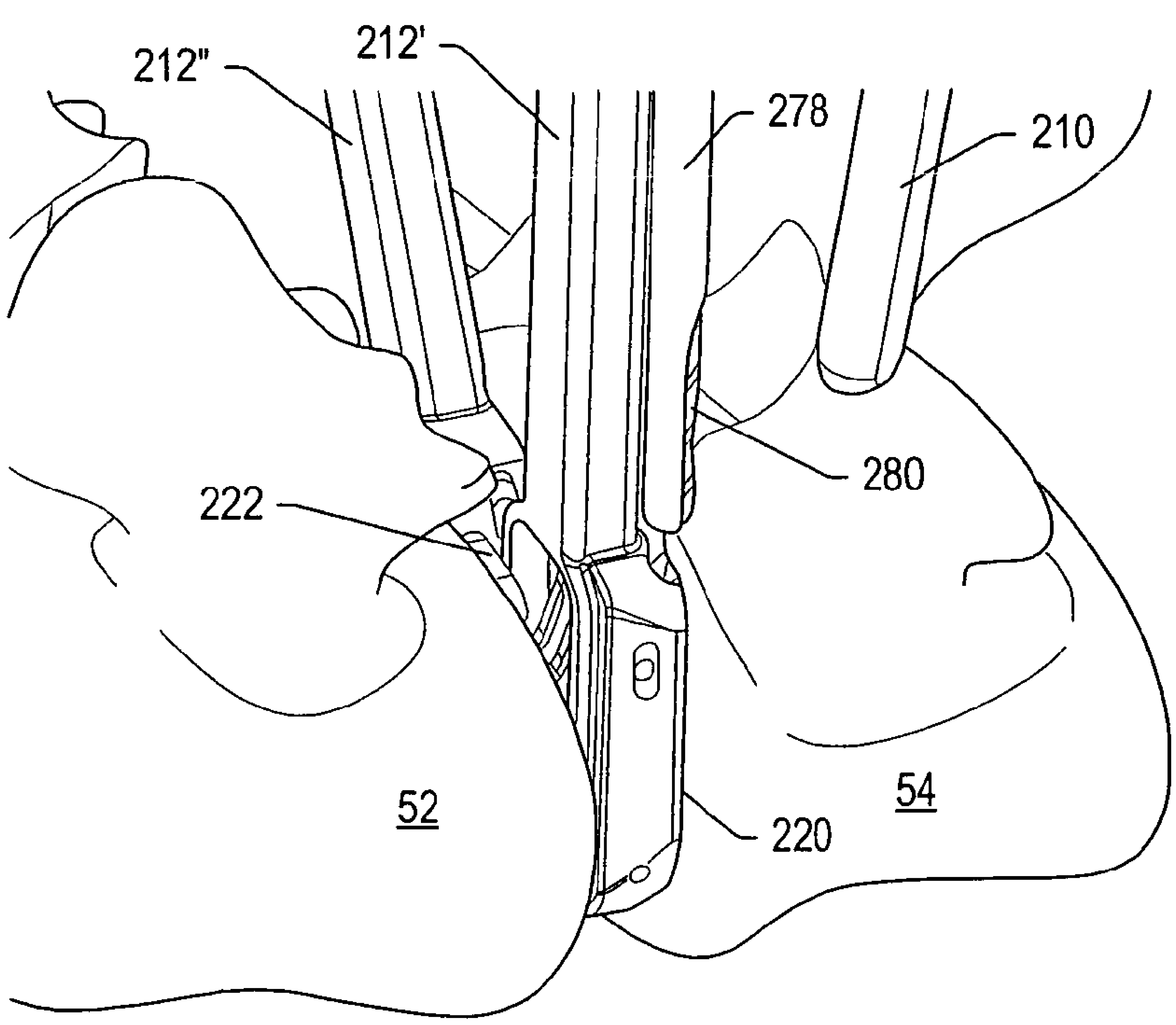

212"
212'
278
210
280
222
52
54
220

FIG. 48

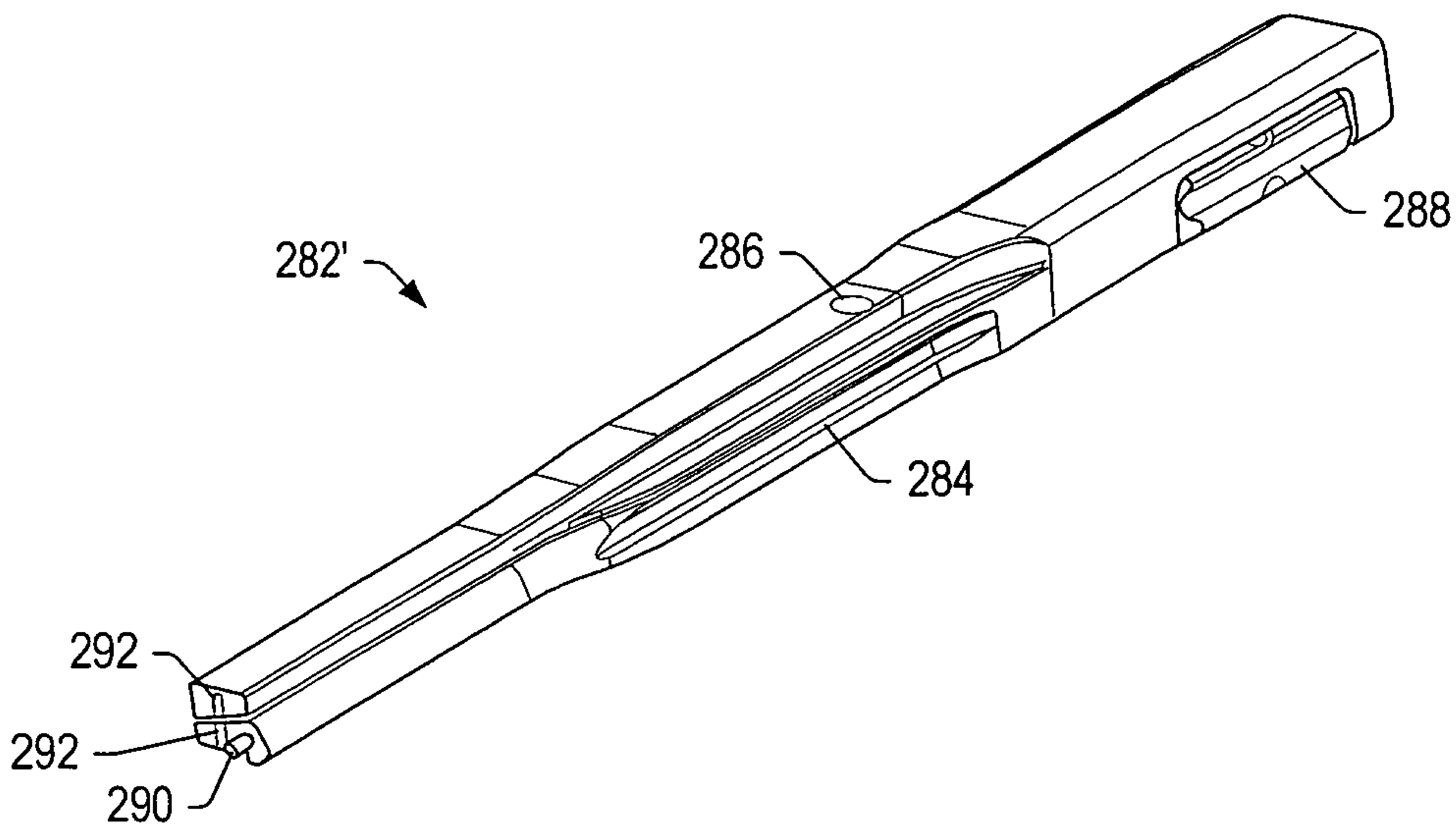

282'
286
288
284
292
292
290

FIG. 49

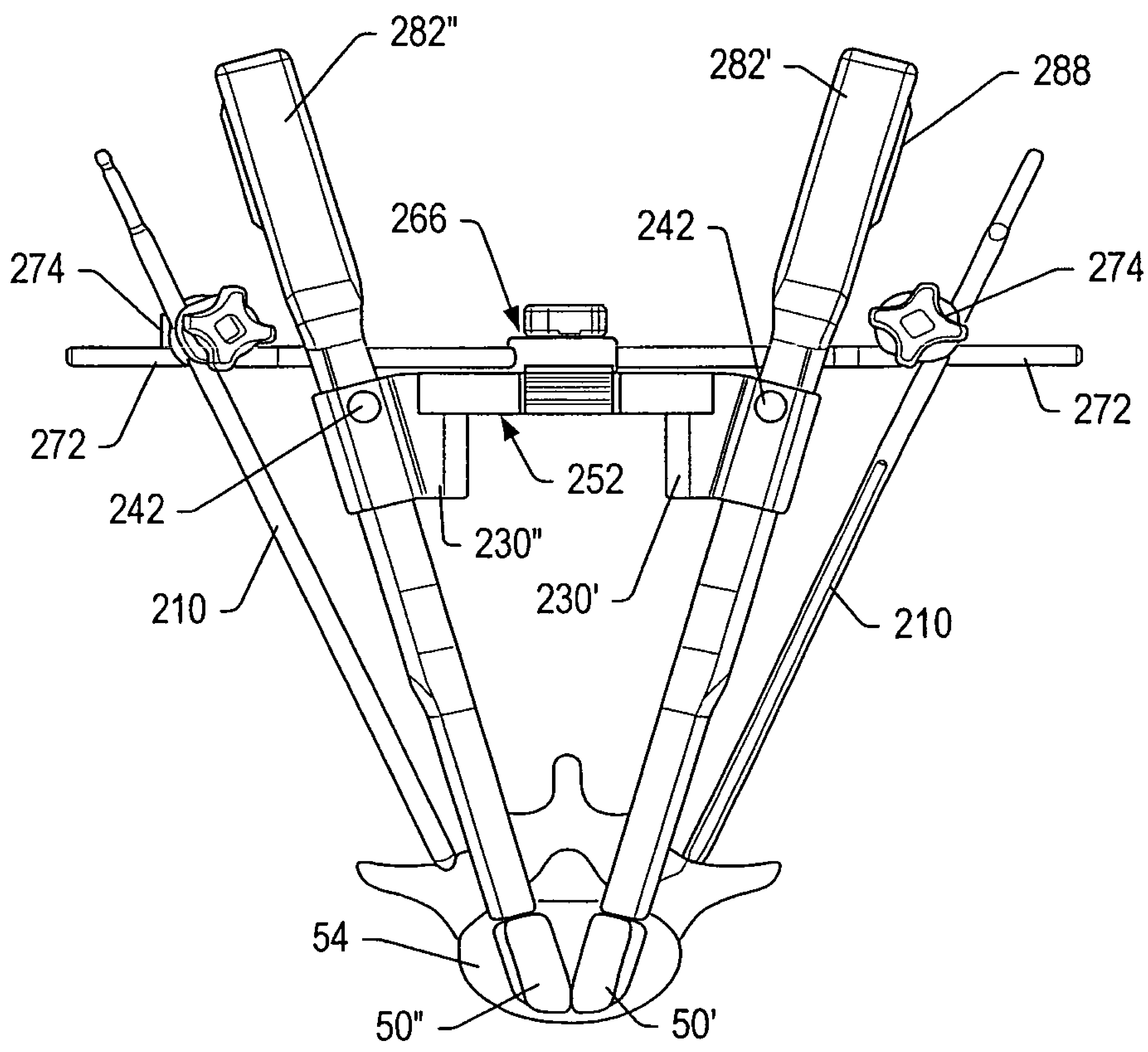
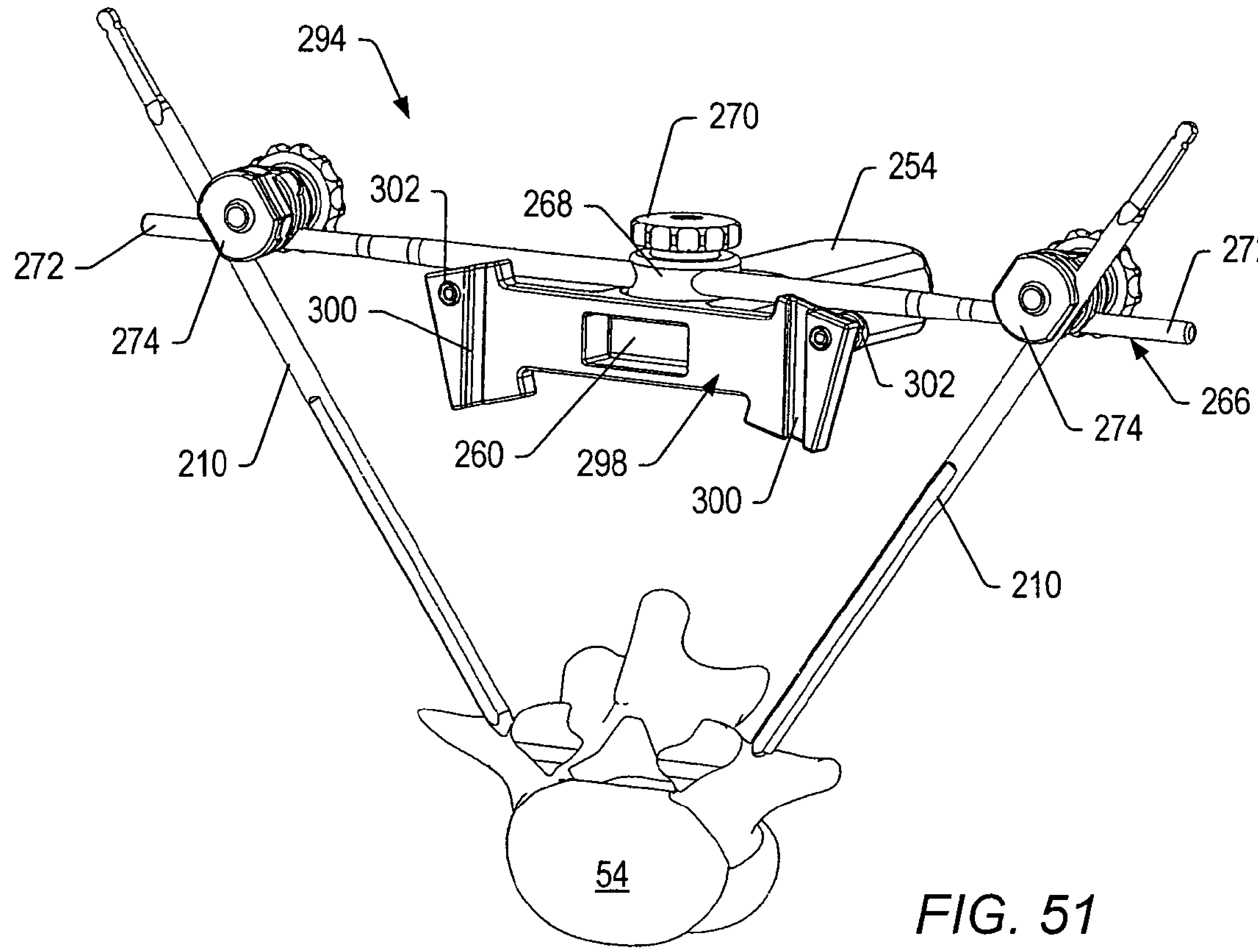

282"
282'
288
266
242
274
274
272
272
242
252
230"
230'
210
210
54
50"
50'

FIG. 50


294
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266
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274
210
54

FIG. 51

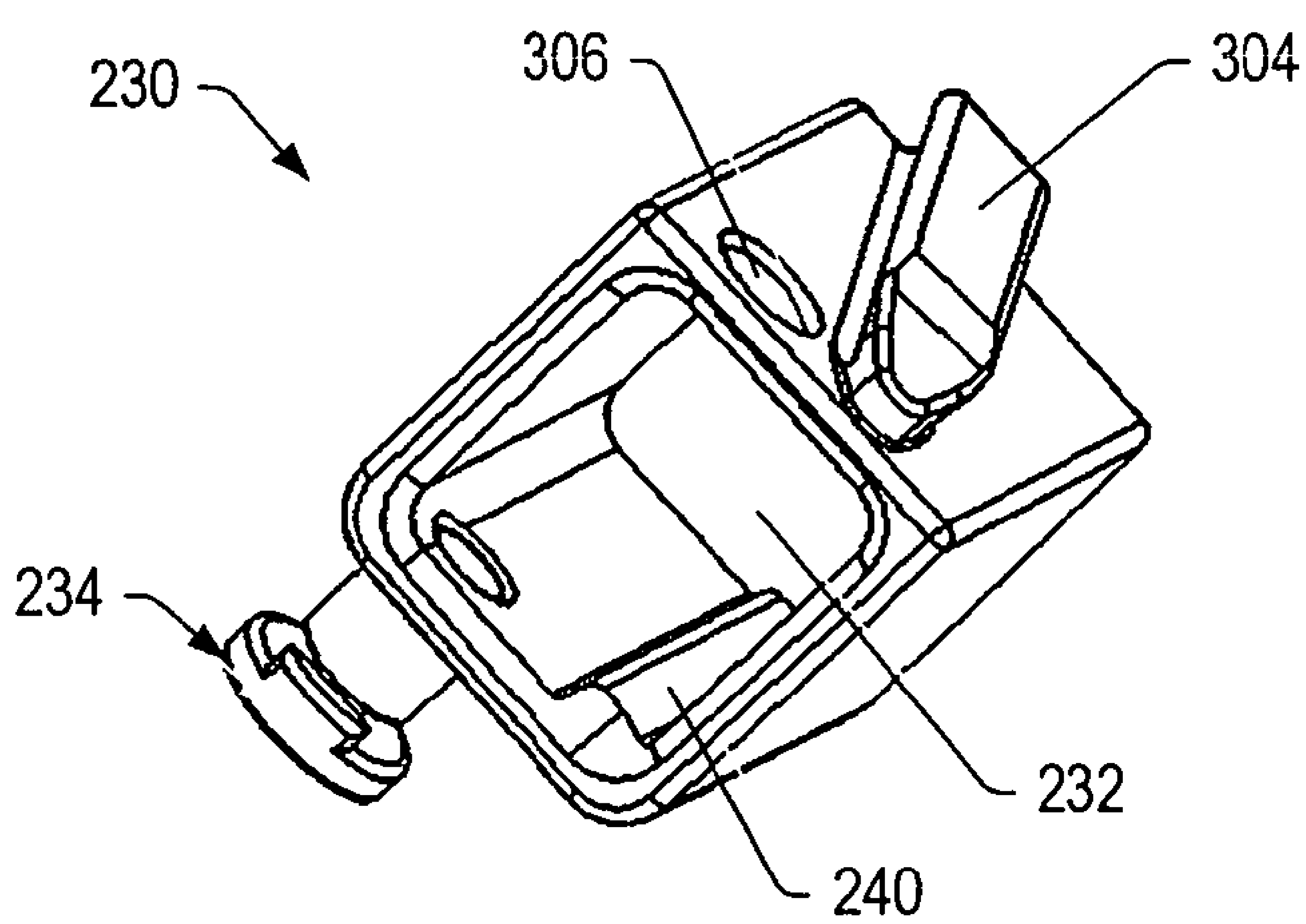
230
306
304
234
232
240

FIG. 52

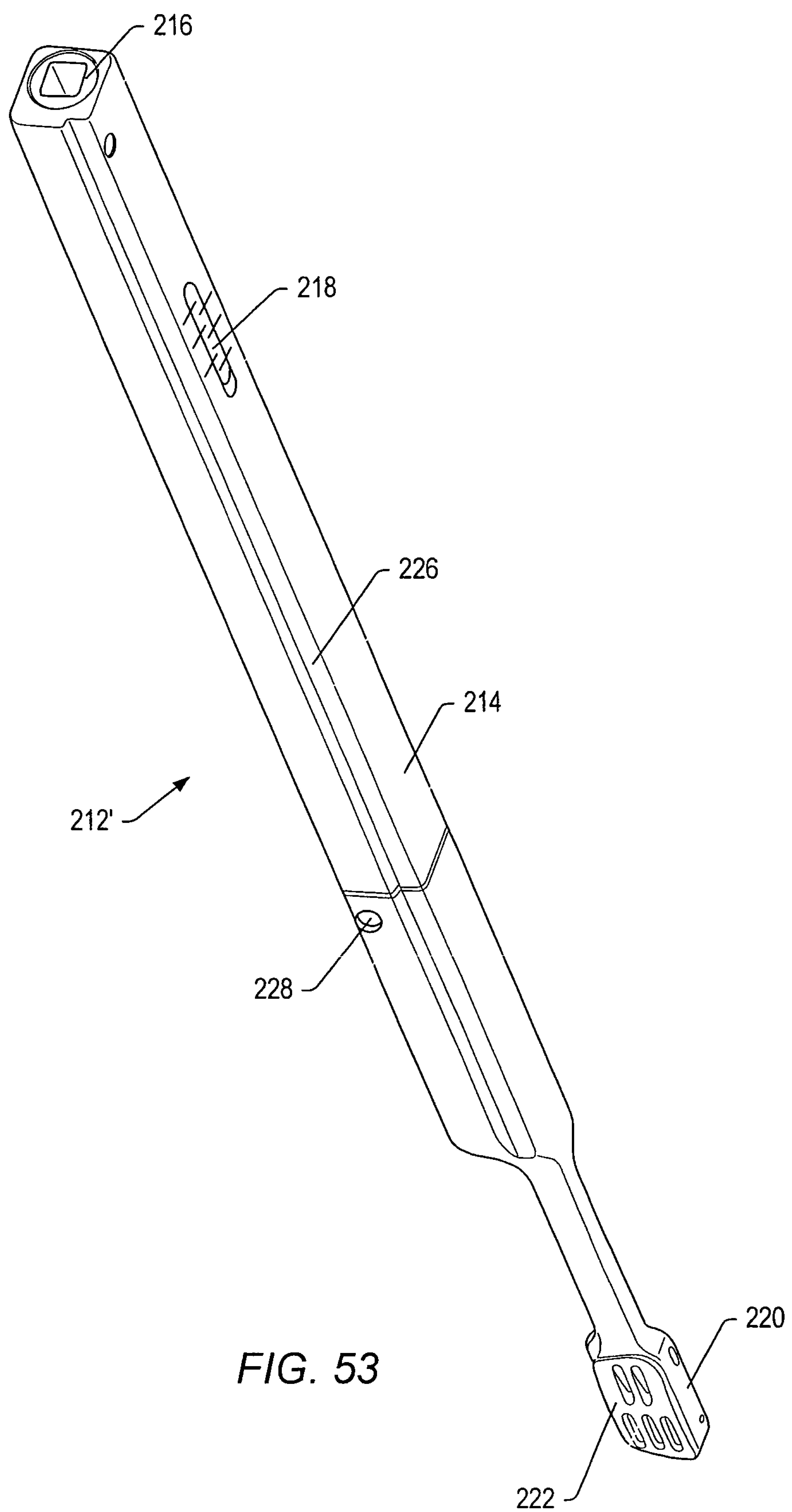

FIG. 53

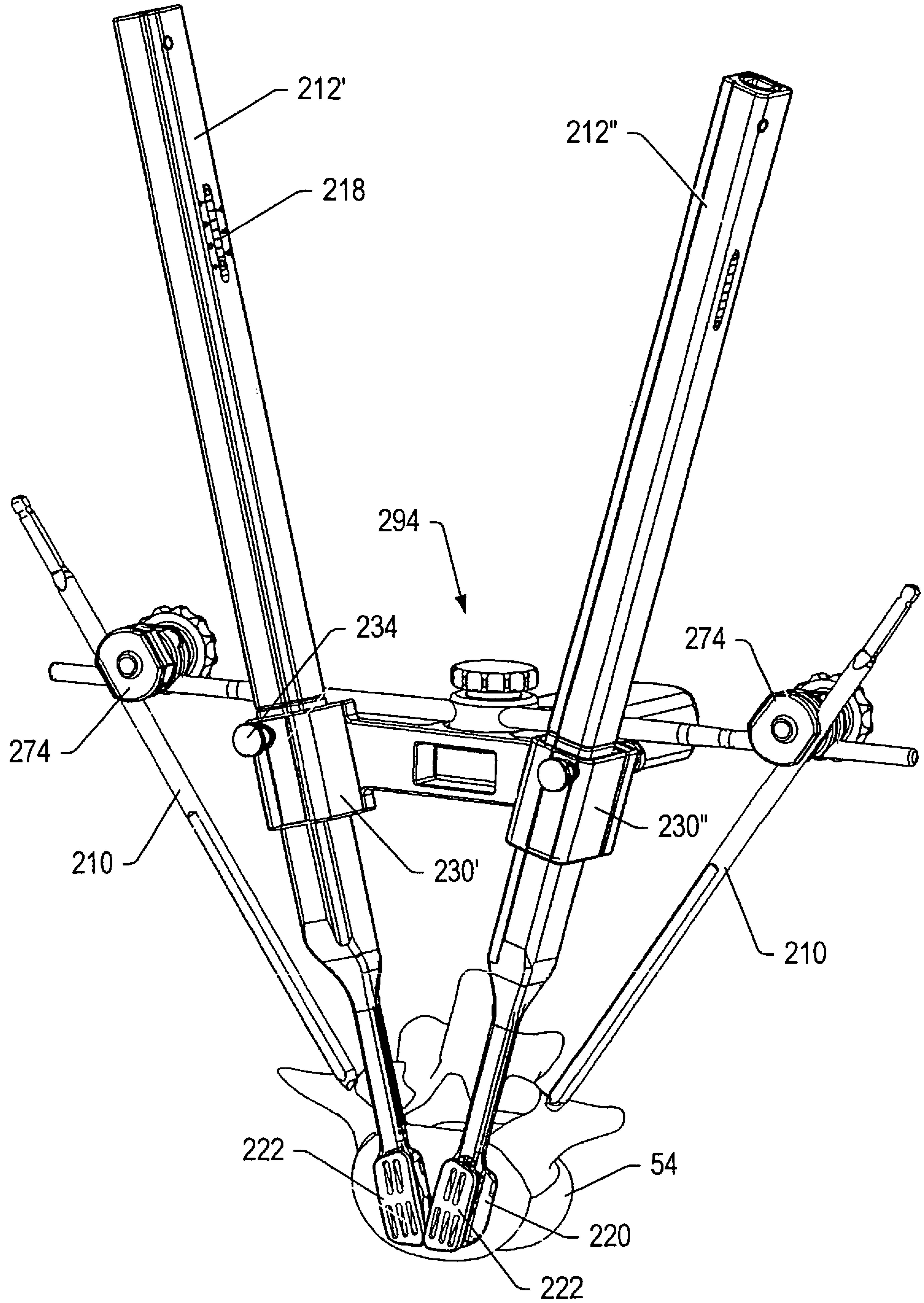

FIG. 54

DYNAMIC INTERBODY DEVICES

BACKGROUND

1. Field of the Invention

Embodiments of the invention generally relate to functional spinal implant assemblies for insertion into an intervertebral space between adjacent vertebrae of a human spine and reconstruction of the posterior elements to provide stability, flexibility, and proper biomechanical motion. More specifically, embodiments relate to dynamic intervertebral devices that allow vertebrae adjacent to the intervertebral devices to have coupled axial rotation and lateral bending. Embodiments also relate to methods of using dynamic interbody devices and dynamic stabilization systems, and to insertion methods for installing dynamic interbody devices and dynamic stabilization systems.

2. Description of Related Art

The human spine is a complex mechanical structure including alternating bony vertebrae and fibrocartilaginous discs that are connected by strong ligaments and supported by musculature that extends from the skull to the pelvis and provides axial support to the body. The intervertebral discs provide mechanical cushion between adjacent vertebral segments of the spinal column and generally include two basic components: the nucleus pulposus and the annulus fibrosis. The intervertebral discs are positioned between two vertebral end plates. The annulus fibrosis forms the perimeter of the disc and is a tough outer ring that binds adjacent vertebrae together. The end plates are made of thin cartilage overlying a thin layer of hard cortical bone that attaches to the spongy, cancellous bone of a vertebra. The vertebrae generally include a vertebral foramen bounded by the anterior vertebral body and the neural arch, which consists of two pedicles that are united posteriorly by the laminae. The spinous and transverse processes protrude from the neural arch. The superior and inferior articular facets lie at the root of the transverse process.

The human spine is a highly flexible structure capable of a high degree of curvature and twist in nearly every direction. However, genetic or developmental irregularities, trauma, chronic stress, and degenerative wear can result in spinal pathologies for which surgical intervention may be necessary. In cases of deterioration, disease, or injury, an intervertebral disc, or a portion of the intervertebral disc, may be removed from the human spine during a discectomy.

After some discectomies, one or more non-dynamic intervertebral devices may be placed in the disc space to fuse or promote fusion of the adjacent vertebrae. During some procedures, fusion may be combined with posterior fixation to address intervertebral disc and/or facet problems. The fusion procedure (e.g., posterior lumbar interbody fusion) and the posterior fixation procedure may be performed using a posterior approach. The posterior fixation and non-dynamic intervertebral devices may cooperate to inhibit motion and promote bone healing. Fusing two vertebrae together results in some loss of motion. Fusing two vertebrae together may also result in the placement of additional stress on one or more adjacent functional spinal units. The additional stress may cause deterioration of an adjacent functional spinal unit that may result in the need for an additional surgical procedure or procedures.

After some discectomies, a dynamic intervertebral device (DID) may be placed in the disc space. The DID may allow for movement of adjacent vertebrae coupled to the DID relative to each other. U.S. Pat. No. 4,863,477 to Monson, which is incorporated herein by reference, discloses a resilient dynamic device intended to replace the resilience of a natural human spinal disc. U.S. Pat. No. 5,192,326 to Bao et al., which is incorporated herein by reference, describes a prosthetic nucleus for replacing just the nucleus portion of a human spinal disc. U.S. Patent Application Publication No. 2005/0021144 to Malberg et al., which is incorporated herein by reference, describes an expandable spinal implant. Allowing for movement of the vertebrae coupled to the disc prosthesis may promote the distribution of stress that reduces or eliminates the deterioration of adjacent functional spinal units.

An intervertebral device may be positioned between vertebrae using a posterior approach, an anterior approach, a lateral approach, or other type of approach. A challenge of positioning a device between adjacent vertebrae using a posterior approach is that a device large enough to contact the end plates and slightly expand the space must be inserted through a limited space. This challenge is often further heightened by the presence of posterior osteophytes, which may cause "fish mouthing" of the posterior vertebral end plates and result in very limited access to the disc. A further challenge in degenerative disc spaces is the tendency of the disc space to assume a lenticular shape, which may require a larger implant than can be easily introduced without causing trauma to adjacent nerve roots. The size of rigid devices that may safely be introduced into the disc space is thereby limited. During some spinal fusion procedures using a posterior approach, two implants are inserted between the vertebrae. During some posterior procedures, one or both facet joints between the vertebrae may be removed to provide additional room for the insertion of a fusion device. Removal of the facet may also allow for the removal of soft tissue surrounding the facet (for example, the facet capsule) that work to resist posterior distraction.

The anterior approach poses significant challenges as well. Though the surgeon may gain very wide access to the interbody space from the anterior approach, this approach has its own set of complications and limitations. The retroperitoneal approach usually requires the assistance of a surgeon skilled in dealing with the visceral contents and the great vessels. The spine surgeon has extremely limited access to the nerve roots and no ability to access or replace the facet joints. Complications of the anterior approach that are approach specific include retrograde ejaculation, ureteral injury, and great vessel injury. Injury to the great vessels may result in massive blood loss, postoperative venous stasis, limb loss, or death. The anterior approach is more difficult in patients with significant obesity and may be virtually impossible in the face of previous retroperitoneal surgery.

A facet joint or facet joints of a functional spinal unit may be subjected to deterioration, disease or trauma that requires surgical intervention. Disc degeneration is often coupled with facet degeneration, so that disc replacement only may not be sufficient treatment for a large group of patients.

Facet degeneration may be addressed using a posterior approach. Thus a second surgical approach may be required if the disc degeneration is treated using an anterior approach. The need to address facet degeneration has led to the development of facet replacement devices. Some facet replacement devices are shown in U.S. Pat. No. 6,419,703 to Fallin et al.; U.S. Pat. No. 6,902,580 to Fallin et al.; U.S. Pat. No. 6,610,091 to Reiley; U.S. Pat. No. 6,811,567 to Reiley; and U.S. Pat. No. 6,974,478 to Reiley et al, each of which is incorporated herein by reference. The facet replacement devices may be used in conjunction with anterior disc replacement devices, but the facet replacement devices are not designed to provide a common center of rotation with the anterior disc replacement devices. The use of an anterior disc replacement device that has a fixed center of rotation contrary to the fixed center of rotation of the facet replacement device may restrict or diminish motion and be counterproductive to the intent of the operation.

Despite the difficulties of the anterior approach, the anterior approach does allow for the wide exposure needed to place a large device. In accessing the spine anteriorly, one of the major structural ligaments, the anterior longitudinal ligament, must be completely divided. A large amount of anterior annulus must also be removed along with the entire nucleus. Once these structures have been resected, the vertebral bodies may need to be over distracted to place the device within the disc space and restore disc space height. Failure to adequately tension the posterior annulus and ligaments increases the risk of device failure and/or migration. Yet in the process of placing these devices, the ligaments are overstretched while the devices are forced into the disc space under tension. Over distraction can damage the ligaments and the nerve roots. The anterior disc replacement devices currently available or in clinical trials may be too large to be placed posteriorly, and may require over distraction during insertion to allow the ligaments to hold them in position.

During some spinal stabilization procedures a posterior fixation system may be coupled to the spine. During some procedures, posterior fixation systems may be coupled to each side of the spine. The posterior fixation systems may include elongated members that are coupled to vertebrae by fasteners (e.g., hooks and screws). In some embodiments, one or more transverse connectors may be connected to the posterior fixation systems to join and stabilize the posterior fixation systems.

During some spinal stabilization procedures, dynamic posterior stabilization systems may be used. U.S. Patent Application Nos. 2005/0182409 to Callahan et al.; 2005/0245930 to Timm et al.; and 2006/0009768 to Ritland, each of which is incorporated herein by reference, disclose dynamic posterior stabilization systems.

During some spinal stabilization procedures, a dynamic interbody device or devices may be used in conjunction with one or more dynamic posterior stabilization systems. U.S. patent application Ser. No. 11/371,188 to Gordon et al., which is incorporated herein by reference, discloses dynamic interbody devices and dynamic posterior stabilization systems that may be used together to stabilize a portion of a spine.

A portion of the load applied to a spine of a patient may apply shear forces to dynamic interbody devices positioned between vertebrae. In some spinal stabilization systems, shear forces applied to the dynamic interbody devices are resisted by rod and pedicle screw constructs. The shear forces may apply large moments to the pedicle screws through the rods that result in undesired loosening of the pedicle screws. In some embodiments, the pedicle screw and rod constructs are relatively massive constructs to accommodate applied shear loads without loosening.

The width of fusion devices or dynamic devices that are installed using a posterior approach may be limited by the available insertion space and/or the need to limit retraction of neural structures exiting the vertebrae being stabilized. Subsidence of the lower vertebra caused by a fusion device or dynamic device inserted using a posterior approach has been noted in some patients. Subsidence may be due to small contact area between the vertebra and the device and/or by limited or no contact of the device over cortical bone surrounding the end plate of the vertebra. The contact surfaces of many fusion devices and/or dynamic interbody devices that are inserted using posterior approaches have substantially the same contact area against the upper vertebra and the lower vertebra being stabilized.

SUMMARY

In an embodiment, one or more dynamic interbody devices for a spine may be inserted in a disc space between vertebrae to form all or part of a stabilization system. The stabilization system for a first vertebra and a second vertebra of a human spine may comprise a first member and a second member coupled to the first member. The first member moves relative to the second member to accommodate coupled lateral bending and axial rotation of the first vertebra relative to the second vertebra when the first member and second member are positioned between the first vertebra and the second vertebra. The first member and the second member comprise a dynamic interbody device.

In an embodiment, the stabilization system for a first vertebra and a second vertebra of a human spine comprises a first member having at least one guide surface and a second member having at least one guide surface configured to interact with the guide surface of the first member. Interaction of a guide surface of the first member with a guide surface of the second member allows for lateral bending of the first vertebra relative to the second vertebra when the first member and second member are positioned between the first vertebra and the second vertebra. The first member and the second member comprise a dynamic interbody device.

In an embodiment, the stabilization system for a first vertebra and a second vertebra of a human spine comprises a first member having at least one guide surface and a second member having at least one guide surface configured to interact with the guide surface of the first member. Interaction of a guide surface of the first member with a guide surface of the second member allows for axial rotation of the first vertebra relative to the second vertebra when the first member and the second member are positioned between the first vertebra and the second vertebra. The first member and the second member comprise a dynamic interbody device.

In an embodiment, the stabilization system for a first vertebra and a second vertebra of a human spine comprises a first dynamic interbody device comprising a first member and a second member, wherein the second member is configured to move relative to the first member to accommodate coupled lateral bending and axial rotation of the first vertebra relative to the second vertebra when the first member and the second member are positioned between the first vertebra and the second vertebra; and a second dynamic interbody device comprising a first member and a second member, wherein the second member is configured to move relative to the first member to accommodate axial rotation and lateral bending of the first vertebra relative to the second vertebra when the first member and the second member are positioned between the first vertebra and the second vertebra.

In an embodiment, the stabilization system for a first vertebra and a second vertebra of a human spine comprises a first dynamic interbody device comprising: a first member having at least one guide surface; a second member having at least one guide surface configured to interact with the guide surface of the first member; and wherein interaction of a guide surface of the first member with a guide surface of the second member allows the second member to move relative to the first member to accommodate lateral bending of the first vertebra relative to the second vertebra when the first member and second member are positioned between the first vertebra and the second vertebra. The stabilization system also comprises a second dynamic interbody device comprising a first member and a second member, wherein the second member is configured to move relative to the first member to accommodate lateral bending of the first vertebra relative to the second vertebra. The first dynamic interbody device includes a portion configured to mate to a portion of the second dynamic interbody device so that the second member of the first dynamic interbody device moves in tandem with the second member of the second dynamic interbody device when the portion of the first dynamic interbody device is connected to the portion of the second dynamic interbody device.

In an embodiment, the stabilization system for a first vertebra and a second vertebra of a human spine comprises a first dynamic interbody device comprising: a first member having at least one guide surface; a second member having at least one guide surface configured to interact with the guide surface of the first member; and wherein interaction of a guide surface of the first member with a guide surface of the second member allows the second member to move relative to the first member to accommodate axial rotation of the first vertebra relative to the second vertebra when the first member and second member are positioned between the first vertebra and the second vertebra. The stabilization system also comprises a second dynamic interbody device comprising a first member and a second member, wherein the second member is configured to move relative to the first member to accommodate axial rotation of the first vertebra relative to the second vertebra when the first member and second member are positioned between the first vertebra and the second vertebra. The first dynamic interbody device includes a portion configured to mate to a portion of the second dynamic interbody device so that the second member of the first dynamic interbody device moves in tandem with the second member of the second dynamic interbody device when the portion of the first dynamic interbody device is connected to the portion of the second dynamic interbody device.

In an embodiment, the stabilization system for a first vertebra and a second vertebra of a human spine comprises a first member configured to couple to the first vertebra, the first member having an inferior surface configured to contact the first vertebra and a width; and a second member configured to couple to an upper vertebra of a pair of vertebra, the second member having a superior surface configured to contact the second vertebra and a width. The first member is coupled to the second member to allow for motion of the first member relative to the second member to accommodate motion of the first vertebra relative to the second vertebra when the first member and the second member are coupled to the first vertebra and second vertebra. The width of the first member is larger than width of the second member.

In an embodiment, the stabilization system for a first vertebra and a second vertebra of a human spine comprises a first member configured to couple to the first vertebra, the first member having an inferior surface configured to contact the first vertebra; a second member coupled to the first member, wherein the second member is configured to move relative to the first member to allow for coupled axial rotation and lateral bending; and a third member coupled to the second member, the third member having a superior surface configured to contact the second vertebra, and wherein the third member is configured to move relative to the second member to accommodate flexion of the first vertebra relative to the second vertebra when the first member and the third member are coupled to the first vertebra and second vertebra. The width of the first member is larger than the width of the third member.

In an embodiment, the stabilization system for a first vertebra and a second vertebra of a human spine comprises a first member configured to couple to the first vertebra, the first member having an inferior surface configured to contact the first vertebra; a second member coupled to the first member, wherein the second member is configured to move relative to the first member to allow for coupled axial rotation and lateral bending; and a third member coupled to the second member, the third member having a superior surface configured to contact the second vertebra, and wherein the third member is configured to move relative to the second member to accommodate extension of the first vertebra relative to the second vertebra when the first member and the third member are coupled to the first vertebra and second vertebra. The surface area of the inferior surface of the first member is larger than the surface area of the superior surface of the third member

In an embodiment, the stabilization system for a first vertebra and a second vertebra of a human spine comprises a first member having a plurality of arcuate grooves and ridges and a second member having a plurality of arcuate grooves and ridges. The grooves and ridges of the first member interact with the grooves and ridges of the second member so that axial rotation of the first vertebra relative to the second vertebra causes lateral bending of the first vertebra relative to the second vertebra when the first member and the second member are positioned between the first vertebra and the second vertebra. The first member and the second member comprise a dynamic interbody device.

In an embodiment, the stabilization system for a first vertebra and a second vertebra of a human spine comprises a first member having a plurality of arcuate grooves and ridges and a second member having a plurality of arcuate grooves and ridges. The grooves and ridges of the first member interact with the grooves and ridges of the second member so that lateral bending of the first vertebra relative to the second vertebra causes axial rotation of the first vertebra relative to the second vertebra when the first member and the second member are positioned between the first vertebra and the second vertebra. The first member and the second member comprise a dynamic interbody device.

In an embodiment, a method for stabilizing a first vertebra and a second vertebra of a human spine comprises inserting a dynamic interbody device into a disc space between the first vertebra and the second vertebra from an anterior side of the first vertebra, wherein a first member of the interbody device is configured to move relative to a second member of the dynamic interbody device to allow for coupled axial rotation and lateral bending of the first vertebra relative to the second vertebra.

In an embodiment, a method for stabilizing a first vertebra and a second vertebra of a human spine comprises inserting a first dynamic interbody device into a disc space on a first side of the first vertebra and the second vertebra from a posterior side of the first vertebra and inserting a second dynamic interbody device into the disc space on a second side of the first vertebra and the second vertebra from the posterior side of the first vertebra. A first member of the first dynamic interbody device is configured to move relative to a second member of the first dynamic interbody device to allow for coupled axial rotation and lateral bending of the first vertebra relative to the second vertebra.

In an embodiment, a method for stabilizing a first vertebra and a second vertebra of a human spine comprises inserting a first dynamic interbody device into a disc space on a first side of the first vertebra and the second vertebra from a posterior side of the first vertebra; inserting a second dynamic interbody device into the disc space on a second side of the first vertebra and the second vertebra from the posterior side of the first vertebra; and coupling the first dynamic interbody device to the second dynamic interbody device. A first member of the first dynamic interbody device is configured to move relative to a second member of the first dynamic interbody device to allow for coupled axial rotation and lateral bending of the first vertebra relative to the second vertebra.

In an embodiment, a method may be used to insert a first dynamic interbody device and a second dynamic interbody device in a disc space between a first vertebra and a second vertebra. The method may include placing taps into the first vertebra, attaching a bridge assembly to the taps and positioning a face of the bridge assembly at a desired position relative to the first vertebra, attaching a first guide and a second guide to the bridge assembly, placing an end of a first expandable trial through the first guide and in the disc space between the first vertebra and the second vertebra, placing an end of a second expandable trial through the second guide and in the disc space between the first vertebra and the second vertebra, adjusting the separation distance between a movable plate and a base plate of the first expandable trial and adjusting the separation distance between a movable plate and a base plate of the second expandable trial, attaching the first dynamic interbody device to an inserter and attaching the second dynamic interbody device to an inserter, removing the first expandable trial from the disc space and first guide, placing the first dynamic interbody device through the first guide and into the disc space, removing the second expandable trial from the disc space and second guide, placing the second dynamic interbody device through the second guide and into the disc space, and releasing the first dynamic interbody device and the second dynamic interbody device from the inserters.

In an embodiment, a method may be used to insert a first dynamic interbody device and a second dynamic interbody device in a disc space between a first vertebra and a second vertebra. The method may include inserting a first expandable trial and a second expandable trial in the disc space between the vertebra, coupling a first guide to the first expandable trial and a second guide to the second expandable trial, attaching a bridge assembly to the first guide and the second guide, adjusting the separation distance between a movable plate and a base plate of the first expandable trial and adjusting the separation distance between a movable plate and a base plate of the second expandable trial, attaching the first dynamic interbody device to an inserter and attaching the second dynamic interbody device to an inserter, removing the first expandable trial from the disc space and guide, placing the first dynamic interbody device through the first guide and into the disc space, removing the second expandable trial from the disc space and second guide, placing the second dynamic interbody device through the second guide and into the disc space, and releasing the first dynamic interbody device and the second dynamic interbody device from the inserters.

BRIEF DESCRIPTION OF THE DRAWINGS

Advantages of the present invention will become apparent to those skilled in the art with the benefit of the following detailed description and upon reference to the accompanying drawings in which:

FIG. **1** depicts embodiments of dynamic interbody devices positioned between vertebrae.

FIG. **2** depicts a rear view of dynamic interbody device embodiments.

FIG. **3** depicts a front view of the first member of a dynamic interbody device embodiment.

FIG. **4** depicts a side view of the first member of the dynamic interbody device embodiment.

FIG. **5** depicts a top view of the first member of the dynamic interbody device embodiment.

FIG. **6** depicts a front view of the second member of the dynamic interbody device embodiment.

FIG. **7** depicts a side view of the second member of the dynamic interbody device embodiment.

FIG. **8** depicts a top view of the second member of the dynamic interbody device embodiment.

FIG. **9** depicts a bottom view of the second member of the dynamic interbody device embodiment.

FIG. **10** depicts a perspective view of the second member of a dynamic interbody device.

FIG. **11** depicts a perspective view of the third member of the dynamic interbody device with the second member depicted in FIGS. **6-9**.

FIG. **12** depicts embodiments of dynamic interbody devices positioned between vertebrae.

FIG. **13** depicts the posterior end of an embodiment of a dynamic interbody device.

FIG. **14** depicts a perspective view of an embodiment of a dynamic interbody device.

FIG. **15** depicts a side view of a first member of the dynamic interbody device depicted in FIG. **14**.

FIG. **16** depicts a top view of the first member of the dynamic interbody device depicted in FIG. **14**.

FIG. **17** depicts a front view of the first member of the dynamic interbody device depicted in FIG. **14**.

FIG. **18** depicts a side view of the second member of the dynamic interbody device depicted in FIG. **14**.

FIG. **19** depicts a top view of the second member of the dynamic interbody device depicted in FIG. **14**.

FIG. **20** depicts a perspective view of the third member of the dynamic interbody device depicted in FIG. **14**.

FIG. **21** depicts a perspective view of an embodiment of a posterior stabilization system.

FIG. **22** depicts a perspective view of an embodiment of a closure member.

FIG. **23** depicts a side view of an embodiment of an elongated member.

FIG. **24** depicts a plot of applied moment versus rotation.

FIG. **25** depicts the components of an embodiment of a first bone fastener of a dynamic posterior stabilization system.

FIG. **26** depicts a top view of an embodiment of a fastener and collar combination for a bone fastener.

FIG. **27** depicts the components of an embodiment of a second bone fastener of a dynamic posterior stabilization system.

FIG. **28** depicts a perspective view of an embodiment of a bridge.

FIG. **29** depicts an embodiment of a dynamic posterior stabilization system with a laterally positioned elongated member.

FIG. **30** depicts a front view representation of the second bone fastener depicted in FIG. **29**.

FIG. **31** depicts an embodiment of a multi-level dynamic posterior stabilization system.

FIG. **32** depicts top view representation of an embodiment of a dynamic posterior stabilization system.

FIG. **33** depicts a front view representation of a portion of an embodiment of a second bone fastener of a dynamic posterior stabilization system.

FIG. **34** depicts a side view representation of a portion of an embodiment of a dynamic posterior stabilization system with a bridge, wherein a portion of the first bone fastener is depicted in cutaway to emphasize the interior of the first bone fastener.

FIG. **35** depicts a representation of a dynamic interbody device and a posterior stabilization system coupled to vertebrae.

FIG. **36** depicts a representation of taps positioned in a lower vertebra during a spinal stabilization procedure.

FIG. **37** depicts a perspective view of an embodiment of an expandable trial.

FIG. **38** depicts a perspective view of an end portion the expandable trial with the movable plate lifted from the base plate.

FIG. **39** depicts a perspective view of the expandable trial that emphasizes the top of the expandable trial.

FIG. **40** depicts a perspective view of an embodiment of a guide.

FIG. **41** depicts a top view of the guide with the guide release in a first position.

FIG. **42** depicts a top view of the guide with the guide release in a second position.

FIG. **43** depicts a perspective view of an embodiment of an insertion bridge.

FIG. **44** depicts a front view of the insertion bridge.

FIG. **45** depicts a perspective view of the bridge coupled to guides and expandable trials.

FIG. **46** depicts a perspective view of a bar assembly coupled to the bridge, guides, and expandable trials.

FIG. **47** depicts a perspective view of a rod connector attached to the tap and the rod of the bar assembly.

FIG. **48** depicts a perspective view of a keel guide and drill during formation of a keel opening in a vertebra.

FIG. **49** depicts a perspective view of an embodiment of an insertion instrument.

FIG. **50** depicts a perspective view of the lower vertebra with insertion instruments placing the dynamic interbody devices at a desired position.

FIG. **51** depicts a perspective representation of an embodiment of a support frame coupled to taps positioned in the lower vertebra.

FIG. **52** depicts a perspective view of an embodiment of a first guide for a bridge assembly.

FIG. **53** depicts a perspective view of an embodiment of an expandable trial.

FIG. **54** depicts a representation of expandable trials positioned against the lower vertebra during the dynamic interbody device insertion procedure.

While the invention may be susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. The drawings may not be to scale. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but to the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the present invention as defined by the appended claims.

DETAILED DESCRIPTION

A "functional spinal unit" generally refers to a motion segment of a spine. The functional spinal unit may include two vertebrae, an intervertebral disc between the vertebrae, and the two facet joints between the vertebrae. An "artificial functional spinal unit" refers to a functional spinal unit where one or more of the components of the functional spinal unit are replaced by implants or devices that permit at least some motion of the spine. At least a portion of the intervertebral disc and/or one or both of the facet joints may be replaced by implants or devices during a spinal stabilization procedure.

As used herein, "coupled" includes a direct or indirect joining or touching unless expressly stated otherwise. For example, a first member is coupled to a second member if the first member contacts the second member, or if a third member is positioned between the first member and the second member.

A "dynamic interbody device" generally refers to an artificial intervertebral implant that allows for flexion/extension, lateral bending and/or axial rotation of vertebrae coupled to the device. The dynamic interbody device may replace a portion or all of an intervertebral disc. In some embodiments, a pair of dynamic interbody devices are installed during a spinal stabilization procedure. In some embodiments, one or more dynamic interbody devices are installed using a posterior approach. In other embodiments, a dynamic interbody device may be installed using an anterior approach or other type of approach. In some embodiments, one or more dynamic interbody devices are placed in a disc space between vertebrae, and at least one posterior stabilization system is coupled to the vertebrae. In some embodiments, one or more dynamic interbody devices are placed in the disc space without coupling a posterior stabilization system to the vertebrae.

In some embodiments, the dynamic interbody device is a bimodal device. Bimodal refers to a device that has at least two separate curved surfaces to accommodate flexion/extension with lateral bending and/or axial rotation.

Dynamic interbody devices may have surfaces that contact vertebrae. In some embodiments, a surface of the dynamic interbody device that contacts a vertebra may include one or more keels, protrusions, and/or osteoconductive/osteoinductive layers or coatings. A keel of the dynamic interbody device may be positioned in a channel formed in a vertebra. The channel may be formed in the vertebra so that the dynamic interbody device will be positioned at a desired location when inserted into the patient. Protrusions of the dynamic interbody device may penetrate an endplate of the vertebra to secure the dynamic interbody device to the vertebra. An osteoconductive/osteoinductive layer may promote bone growth that secures the dynamic interbody device to the vertebra. The osteoconductive/osteoinductive layer may include, but is not limited to a scaffold, a roughened surface, a surface treated with a titanium plasma spray, bone morphogenic proteins, and/or hydroxyapatite. A roughened surface may be formed by chemical etching, by surface abrading, by shot peening, by an electrical discharge process, and/or by embedding particles in the surface.

An anterior end of a dynamic interbody device may have a height that is greater than the height of a posterior end of the dynamic interbody device. The difference in heights between the anterior end and the posterior end of the dynamic interbody device may provide the patient with a desired amount of lordosis. Dynamic interbody devices that provide different amounts of lordosis may be provided in an instrument kit supplied for a spinal stabilization procedure. For example, the instrument kit for a posterior spinal stabilization procedure may include pairs of dynamic interbody devices that establish 0°, 3°, 6°, 9°, 12° or 15° of lordosis. Other dynamic interbody device lordosis angles or lordosis angle ranges may be provided. The amount of lordosis provided by a dynamic interbody device may be printed or etched on a visible surface of the dynamic interbody device. Other information may also be printed or etched on the visible surface of the dynamic interbody device. Such information may include dimension information (e.g., length, width, and/or height) and whether the dynamic interbody device is to be installed on the left side of the patient or the right side of the patient.

In some embodiments, one or more dynamic interbody devices are installed in a disc space formed between vertebrae during a spinal stabilization procedure. The shape and/or size of a dynamic interbody device may depend on a number of factors including surgical approach employed for insertion, intended position in the spine (e.g., cervical or lumbar), and patient anatomy. A dynamic interbody device for the lumbar spine may have a height that is less than about 22 mm. Several sizes of interbody devices may be provided in the instrument kit for the spinal stabilization procedure. In an embodiment, dynamic interbody devices having heights of 6 mm, 8 mm, 10 mm, 12, mm, 14 mm, 16 mm, 18 mm, and 20 mm are provided in the instrument kit for the spinal stabilization procedure. Other sizes and/or different height ranges of dynamic interbody devices may be provided in the instrument kit for the spinal stabilization procedure. The dynamic interbody devices may include indicia indicating the height of the spinal stabilization devices.

The dynamic interbody devices may allow for flexion/extension. The dynamic interbody device may allow for a maximum of about 20° of flexion from the neutral position. The dynamic interbody device may be designed so that the dynamic interbody device has a smaller or a larger maximum angle of flexion from the neutral position. In some embodiments, the dynamic interbody device allows for a maximum of about 7° of flexion from the neutral position. In some embodiments, the maximum amount of flexion allowed by the dynamic interbody device is substantially the same as the maximum amount of extension allowed by the dynamic interbody device. In some embodiments, the maximum amount of flexion allowed by the dynamic interbody device is different from the maximum amount of extension. For example, an embodiment of a dynamic interbody device allows for a maximum of about 15° of flexion and a maximum of about 10° of extension.

The dynamic interbody device may allow for up to about 5° of axial rotation of vertebrae coupled to the dynamic interbody device (e.g. ±2.5° of rotation from a neutral position). The dynamic interbody device may allow for more or less axial rotation. In an embodiment, the dynamic interbody device allows for about ±1.5° of axial rotation of vertebrae coupled to the dynamic interbody device from a neutral position.

The dynamic interbody device may allow for up to about 10° of lateral bending of vertebrae coupled to the dynamic interbody device (e.g. ±5° of lateral bending from a neutral position). The dynamic interbody device may allow for more or less lateral bending. In an embodiment, the dynamic interbody device allows for about ±3° of lateral bending of vertebrae coupled to the dynamic interbody device from a neutral position.

The dynamic interbody device may allow for coupled lateral bending and axial rotation so that axial rotation causes some lateral bending and lateral bending causes some axial rotation. The dynamic interbody device may be formed so that a set amount of lateral bending results in a set amount of axial rotation. For example, 1° of lateral bending results in about 0.5° of axial rotation (i.e. a 2:1 ratio of lateral bending to axial rotation). A 4:1, 3:1, 2.5:1, 2:1, 1.5:1, 1:1 or other ratio of lateral bending to axial rotation may be set for the dynamic interbody devices. In some embodiments, dynamic interbody devices may be designed to be positioned between two particular vertebrae (e.g., between L4 and L5, between L3 and L4, etc.). The ratio of lateral bending to axial rotation may be selected mimic the natural ratio of lateral bending to axial rotation for normal vertebrae of the same level.

In some embodiments, a pair of dynamic interbody devices may be installed between two vertebrae to establish all or a portion of a spinal stabilization system. Each dynamic interbody device of the pair of dynamic interbody devices may be installed using a posterior approach.

In some embodiments, a single dynamic interbody device may be positioned in a disc space between vertebrae. The use of a single dynamic interbody device may avoid the need to have left oriented and right oriented dynamic interbody devices. The single dynamic interbody device may be installed using an anterior approach, a posterior approach, or a different type of approach. Single dynamic interbody devices inserted using an anterior approach may be installed using installation procedures known in the art. The coupled axial rotation/lateral bending of the anterior dynamic interbody device includes the functionality of the facet joints. One or both of the facets may be removed using a simple minimally invasive procedure without the need to install a posterior stabilization system.

As used herein a "dynamic posterior stabilization system" generally refers to an apparatus used to replace or supplement a facet joint while allowing for both dynamic resistance and at least some motion of the first vertebra to be stabilized relative to the second vertebra to be stabilized. The first vertebra and the second vertebra may be vertebrae of a functional spinal unit. In some embodiments, bone fasteners of the dynamic posterior stabilization system are secured to the first vertebra and the second vertebra. In some embodiments, a bone fastener of the dynamic posterior stabilization system may be coupled to a vertebra adjacent to the vertebrae of the functional spinal unit being stabilized. The bone fasteners may be coupled to lamina, pedicles, and/or vertebral bodies of the vertebrae. In some embodiments, dynamic posterior stabilization systems may be positioned in three or more vertebrae to form a multi-level stabilization system.

The dynamic posterior stabilization system may replace or supplement a normal, damaged, deteriorated, defective or removed facet joint. The dynamic posterior stabilization system may include bone fasteners, an elongated member, and at least one bias member. The bias member may provide little initial resistance to movement of a first vertebra coupled to the system relative to a second vertebra coupled to the system. Resistance to additional movement of the first vertebra relative to the second vertebra may increase. The increasing resistance provided by the bias member may mimic the behavior of a normal functional spinal unit. The dynamic posterior stabilization system may stabilize the vertebrae, limit the range of motion of the first vertebra relative to the second vertebra, and/or share a portion of the load applied to the vertebrae.

The dynamic posterior stabilization systems disclosed herein may allow for rotational and/or translational motion of an elongated member (e.g., a rod or plate) relative to one or more bone fasteners. The bone fasteners may include threading, barbs, rings or other protrusions that secure the bone fasteners to vertebrae. In some embodiments, the bone fasteners may be cemented or glued to the vertebrae. Bone fasteners may include collars. In some embodiments, a collar of a bone fastener is an integral portion of the bone fastener. In some embodiments, the collar is a separate component that is coupled to at least one other component of the bone fastener. The collar of the bone fastener is the portion of the bone fastener that couples to an elongated member of the dynamic posterior stabilization system. In some embodiments, the bone fasteners are polyaxial pedicle screws and the collars are the upper portions of the polyaxial pedicle screws. In some embodiments, the bone fasteners are bone screws and the collars are plates or other structures that are coupled to the bone screws.

During installation of dynamic interbody devices of a spinal stabilization system, or during installation of a single dynamic interbody device, one or both facet joints of the vertebrae may be removed. A dynamic posterior stabilization system may be installed to replace a removed facet joint. One or both of the dynamic interbody devices of the spinal stabilization system, or the single dynamic interbody device, may be coupled to a dynamic posterior stabilization system. Coupling a dynamic interbody device to the dynamic posterior stabilization system may inhibit backout of the dynamic interbody device from the disc space.

In some embodiments, a dynamic posterior stabilization system may be installed without removal of a facet joint. The dynamic posterior stabilization system may be installed after a discectomy, laminectomy, or other procedure. The dynamic posterior stabilization system may change the dynamic resistance that is not normal due to degeneration, disease, loss of a portion of the intervertebral disc and/or tissue damage.

A dynamic interbody device and a dynamic posterior stabilization system may include one or more biocompatible metals having a non-porous quality and a smooth finish (e.g., surgical grade stainless steel, titanium and/or titanium alloys). In some embodiments, a dynamic interbody device or dynamic posterior stabilization system may include ceramic and/or one or more other suitable biocompatible materials, such as biocompatible polymers and/or biocompatible metals. Biocompatible polymers may include, but are not limited to, polyetheretherketone resins ("PEEK"), carbon reinforced PEEK, ultra high molecular weight polyethylenes, polyethylenes, polyanhydrides, and alpha polyesters. For example, a dynamic interbody device or a dynamic posterior stabilization system may be constructed of a combination of biocompatible materials including cobalt chromium alloy, ultra high molecular weight polyethylene, and polycarbonate—urethane or silicone blend.

Dynamic interbody devices may include surfaces that mate with complementary surfaces and allow for motion of vertebrae coupled to the dynamic interbody devices. Components or members of dynamic interbody devices may be formed using CNC (computer numerical control) machining or other techniques. Some surfaces of the dynamic interbody devices may be treated to promote movement of the surfaces and/or inhibit galling. For example, two surfaces that move relative to each other may have mismatched hardness and/or different surface finish orientations to promote free movement of the surfaces relative to each other.

In some embodiments, dynamic interbody devices and dynamic posterior stabilization systems may be made of non-magnetic, radiolucent materials to allow unrestricted intra-operative and post-operative imaging. Certain material may interfere with x-ray and/or magnetic imaging. Magnetic materials may interfere with magnetic imaging techniques. Most non-magnetic stainless steels and cobalt chrome contain enough iron and/or nickel so that both magnetic imaging and x-ray imaging techniques are adversely affected. Other materials, such as titanium and some titanium alloys, are substantially iron free. Such materials may be used when magnetic imaging techniques are to be used, but such materials are often radio-opaque and sub-optimal for x-ray imagining techniques. Many ceramics and polymers are radiolucent and may be used with both magnetic imaging techniques and x-ray imaging techniques. The dynamic interbody devices and/or the dynamic posterior stabilization systems may include coatings and/or markers that indicate the positions of the devices and/or systems during operative and/or post-operative imaging.

In some embodiments, two dynamic interbody devices may be positioned in a disc space between two vertebrae during a spinal stabilization procedure. The largest width of each dynamic interbody device may be less than one half the width of the vertebrae the dynamic interbody devices are to be positioned between. FIG. **1** depicts embodiments of dynamic interbody devices **50'**, **50"** that may be implanted using a posterior approach. Anterior ends and/or posterior ends of dynamic interbody devices **50'**, **50"** may be positioned near the edge of the endplates of vertebrae **52**, **54** so that the dynamic interbody devices abut strong, supportive bone of the vertebrae to be stabilized. Dynamic interbody devices **50'**, **50"** may be bilateral devices with coupled axial rotation and lateral bending.

FIG. **2** depicts a rear view of dynamic interbody devices **50'**, **50"**. Each dynamic interbody device **50'** or **50"** may include first member **56**, second member **58** and third member **60**. First members **56** may be coupled to second members **58** so that dynamic interbody devices **50'**, **50"** accommodate lateral bending and axial rotation of vertebrae coupled to the dynamic interbody devices. In some embodiments, dynamic interbody devices **50'**, **50"** couple lateral bending and axial motion together so that lateral bending motion causes axial rotation, and axial rotation causes lateral bending. Third members **60** may be coupled to second members **58** so that dynamic interbody device **50'**, **50"** accommodate flexion and extension of vertebrae coupled to the dynamic interbody device. Dynamic interbody devices **50'**, **50"** are shown in positions of neutral lateral bending, neutral axial rotation and maximum flexion in FIG. **2**.

In some embodiments, the first members are coupled to the second members to allow for lateral bending without coupled axial rotation. In some embodiments, the first members are coupled to the second members to allow for axial rotation without coupled lateral bending.

In some embodiments, first member **56** of dynamic interbody device **50'** may be substantially a mirror image first member **56** of dynamic interbody device **50"**, and third member **60** of dynamic interbody device **50'** may be substantially a mirror image of third member **60** of dynamic interbody device **50"**. In other embodiments, the first member of dynamic interbody device **50'** may have a shape that is different than the mirror image of the first member of dynamic interbody device **50"** and/or the third member of dynamic interbody device **50'** may have a shape that is different than the mirror image of the third member of dynamic interbody device **50"**.

Second member **58** of dynamic interbody device **50'** may be substantially the mirror image of second member **58** of dynamic interbody device **50"** with the exception of second member **58** of dynamic interbody device **50'** having portion **62** that engages portion **64** of second member **58** of dynamic interbody device **50"** to join dynamic interbody device **50'** to dynamic interbody device **50"** when the dynamic interbody devices are positioned between vertebrae. In other embodiments, first member **56** of dynamic interbody device **50'** has a portion that engages a portion of first member **56** of dynamic interbody device **50"** when the dynamic interbody devices are positioned between vertebrae. In other embodiments, third member **60** of dynamic interbody device **50'** has a portion that engages a portion of first member **60** of dynamic interbody device **50"** when the dynamic interbody devices are positioned between vertebrae.

FIG. **3** depicts a front view of first member **56** of dynamic interbody device **50'**. FIG. **5** depicts a side view of first member **56** of dynamic interbody device **50'**. FIG. **4** depicts a top view of first member **56** of dynamic interbody device **50'**. First member **56** may include keel **66**, superior surface **68**, slot **70**, and opening **72**. Keel **66** may reside in a groove or recess formed in a vertebra when dynamic interbody device **50'** is positioned in a disc space between vertebrae. Keel **66** may inhibit undesired movement of dynamic interbody device **50'** relative to the vertebrae.

Superior surface **68** of first member **56** may be curved. The curvature of superior surface **68** may complement a curvature of an inferior surface of the second member of the dynamic interbody device to allow the dynamic interbody device to accommodate lateral bending.

First member **56** may include arcuate slot **70**. Arcuate slot **70** may interact with a complementary protrusion of the second member to allow the dynamic interbody device to accommodate axial rotation. The curvature of superior surface **68** and arcuate slot **70** allows the dynamic interbody device to provide coupled lateral bending and axial rotation to vertebrae adjacent to the dynamic interbody device. In some embodiments, the second member may have an arcuate slot and the first member may have a complementary protrusion.

Arcuate slot **70** and the protrusion of the second member may be dovetailed or include another type of interconnection system that inhibits non-rotational separation of first member **56** from the second member when the protrusion of the second member is engaged in the slot of the first member. End surfaces **74** of arcuate slot **70** may interact with the end surfaces of the protrusion of the second member to resist shear load applied to the dynamic interbody device when the dynamic interbody device is positioned between vertebrae. End surfaces **74** and the end surfaces of the protrusion of the second member may be guides for lateral bending axial rotation of vertebrae coupled to the dynamic interbody device.

First member **56** may include opening **72** in slot **70**. A pin may be positioned in opening **72**. The pin may reside in a groove in the second member to define the maximum amount of lateral bending/axial rotation allowed by the dynamic interbody device. In other embodiments, a pin positioned in an opening in the second member may reside in a groove in the first member to define the maximum amount of lateral bending/axial rotation allowed by the dynamic interbody device.

FIG. **6** depicts a front view of second member **58** of dynamic interbody device **50'**. FIG. **7** depicts a side view of first member **58** of dynamic interbody device **50'**. FIG. **8** depicts a top view of first member **58** of dynamic interbody device **50'**. FIG. **9** depicts a bottom view of second member **58** of dynamic interbody device **50'**. Second member **58** may include inferior surface **76**, recessed surface **77**, superior surface **78**, protrusion **80**, bearing **82**, tabs **84**, groove **86**, and portion **62**. Some of inferior surface **76** may rest on the superior surface of the first member when protrusion **80** is placed in the arcuate slot of the first member. Inferior surface **76** may include a curvature that complements the curvature of the superior surface of the first member and protrusion **80** may complement the arcuate slot in the first member so that the dynamic interbody device is able to accommodate coupled lateral bending and axial rotation of vertebra joined to the dynamic interbody device

Portion **62** of second member **58** of the dynamic interbody device (shown in FIG. **6**) may engage a complementary portion of the second member of a second dynamic interbody device positioned adjacent to the dynamic interbody device when the dynamic interbody devices are positioned in a disc space between vertebrae. FIG. **10** depicts second member **58** with portion **64** that complements portion **62** of second member shown in FIG. **6**. Engaging portion **62** with complementary portion **64** of the second dynamic interbody device may stabilize the dynamic interbody devices when the dynamic interbody devices are positioned between vertebrae. Coupling the dynamic interbody devices together with portions **62**, **64** may assure that the second members of the dynamic interbody devices move in tandem relative to the first members of the dynamic interbody devices.

Coupling the dynamic interbody devices together with portions **62**, **64** may inhibit migration of the dynamic interbody devices and/or subsidence of the vertebrae coupled to the dynamic interbody devices. Having complementary portions may require that a specific dynamic interbody device be installed prior to the other dynamic interbody device during an insertion procedure. For example, the dynamic interbody device with a female connection portion (i.e., portion **64** in FIG. **10**) may need to be installed first. After insertion, migration and/or removal of the dynamic interbody devices is only possible by reversing the insertion order with the two dynamic interbody devices held in the same position as during insertion (i.e., neutral in axial rotation and lateral bending while in full flexion). Proper positioning of the two dynamic interbody devices may be determined by examining the position of the connected portions using imaging techniques before removal of the insertion instruments.

As shown in FIG. **7**, second member **58** may include bearing **82**. Bearing **82** may fit in a recess of the third member to allow the dynamic interbody device to accommodate flexion and extension of vertebra coupled to the dynamic interbody device. Bearing **82** may include tabs **84**. Tabs **84** may fit in tracks in the third member to inhibit separation of second member **58** from the third member. To assemble the dynamic interbody device, the third member may be coupled to the second member. The second member may be coupled to the first member. The first member will inhibit separation of the third member from the second member even when the dynamic interbody device is subjected to the maximum amount of extension.

As shown in FIG. **9**, groove **86** may be formed in protrusion **80** of second member **58**. In some embodiments, groove **86** may be open at one side of second member **58**. A pin in the first member may reside in groove **86** of the assembled dynamic interbody device.

Second member **58** may include recessed surface **77** in inferior surface **76**. Recessed surface **77** may allow a portion of second member **58** to extend over a portion of the first member of the second dynamic interbody device without interference during lateral bending.

FIG. **11** depicts a perspective view that emphasizes bottom surface of third member **60**. Third member **60** may include recess **88** with tracks **90**. Recess **88** and tracks **90** may complement the bearing and tabs of the second member.

As shown in FIG. **2**, first member **56** of each dynamic interbody device **50'**, **50"** may include opening **92**. Opening **92** may be a threaded opening or have another type of releasable coupling mechanism. Opening **92** may be used to releasably couple the dynamic interbody device to an insertion instrument. In other embodiments, openings for the insertion instrument may be located in the second member and/or the third member.

The dynamic interbody device may include one or more features that allow the insertion instrument to hold the dynamic interbody device in a desired position. For example, first member **56** may include slot **94** and third member **60** may include slot **96**. A portion of the insertion instrument may be placed in slots **94**, **96**. The portion of the insertion instrument that fits in slots **94**, **96** may place the dynamic interbody device in a desired position for insertion between vertebrae (i.e., neutral axial rotation, neutral lateral bending, and full flexion).

FIG. **12** depicts alternate embodiments of dynamic interbody devices **50'**, **50"** positioned between vertebra **52**, **54**. Each dynamic interbody device may include first member **56**, second member **58** and third member **60**. First member **56** and second member **58** may include complementary curved ridges that allow for coupled lateral bending and axial rotation of vertebrae **52**, **54** that the dynamic interbody devices are positioned between. In some embodiments, the second member includes a guide recess. A guide pin of the first member resides in the guide recess to join the first member and the second member together and/or to limit the amount of axial rotation and lateral bending allowed by the dynamic interbody device. The first member may include undercut surfaces. The undercut surfaces of the first member may interact with undercut surfaces of the second member to inhibit separation of the first member from the second member and to take a portion of the shear load applied to the dynamic interbody device.

A tab of third member **60** may be placed in a slot of second member **58**. A pin may be positioned in second member **58** through an opening in the slot to join the second member to third member **60**. Second member **58** may include bearing **82**. Third member **60** may include a recess with a curved surface that complements the curve of bearing **82**. The coupling of the recess of third member **60** with the bearing of second member **58** may accommodate flexion and extension of vertebrae **52**, **54** that dynamic interbody devices **50'**, **50"** are positioned between.

Dynamic interbody devices **50'**, **50"** work in conjunction to allow for coupled lateral bending and axial rotation and/or flexion/extension of vertebrae **52**, **54** the dynamic interbody devices are positioned between. During an insertion procedure, careful positioning of the dynamic interbody devices **50'**, **50"** may be needed to ensure that dynamic interbody device **50'** works in conjunction with dynamic interbody device **50"**. In some dynamic interbody device embodiments, a separation angle of about **30**° (i.e., each implant oriented at about 15° from a center line of endplate of the lower vertebra being stabilized) is desired between dynamic interbody devices **50'**, **50"**. Other embodiments of dynamic interbody devices may be designed to operate in conjunction with each other at other separation angles.

In some embodiments, insertion instruments may allow insertion of dynamic interbody devices **50'**, **50"** so that ends of the dynamic interbody devices touch. Intra-operative imaging may be used to ensure the proper positioning and alignment of the dynamic interbody devices. In some embodiments, a portion of dynamic interbody device **50'** may engage a portion of dynamic interbody device **50"** to ensure proper positioning of the dynamic interbody devices **50'**, **50"**. For example, a dovetailed portion of dynamic interbody device **50'** fits in a complementary groove of dynamic interbody device **50"** when the dynamic interbody devices are properly positioned. Engaging dynamic interbody devices may inhibit migration of the dynamic interbody devices after insertion.

FIG. **13** depicts the posterior end of dynamic interbody device **50'** when there is no lateral bending or axial rotation of second member **58** of the dynamic interbody device relative to first member **56**. In some embodiments, first member **56** may be wider than second member **58** and third member **60**. First member **56** may abut the lower vertebra of the vertebrae to be stabilized. Having the first member wider than second member **58** and/or third member **60** may take advantage of the space available for insertion of the dynamic interbody devices between the vertebrae.

In many previous devices inserted using a posterior approach, the width of the portion of the device that contacted the upper vertebra was substantially the same as the width of the portion of the device that contacted the lower vertebra. The width of devices was typically the largest width that allowed insertion of the portion of the device that contacted the upper vertebra without undue retraction of neural structures exiting between the vertebrae. The space available for insertion of a device using a posterior approach is typically wider near the lower vertebra and becomes less wide nearer the upper vertebra.

In some embodiments, second member **58** and third member **60** may include curved dovetailed slots **98**. Slots **98** may accept a first portion of an inserter. When the first portion of the inserter is coupled to slots **98** of second member **58** and third member **60**, movement of the second member relative to the third member (e.g., flexion/extension) is inhibited. First member **56** may include inserter opening **92**. Inserter opening **92** may be threaded. A second portion of the inserter may fit in inserter opening **92**. When the first portion of the inserter is coupled to slots **98** and the second portion of the inserter is positioned in inserter opening **92**, movement of first member **56** relative to second member **58** is inhibited.

The first member of the dynamic interbody device may be wider than the third member to take advantage of the available insertion space for the dynamic interbody devices. Having first members with large widths provides large contact area between the first members and the lower vertebra. The large contact area may inhibit subsidence of the vertebra that is more likely to subside due to the presence of the dynamic interbody devices. Even though third member may be less wide than first member, the third member provides sufficient contact against the upper vertebra to inhibit subsidence of the upper vertebra.

Pairs of dynamic interbody devices having different widths, lengths, and/or heights may be provided in the instrument kit for the spinal stabilization procedure. For example, the instrument kit may include pairs of implants having small widths, medium widths, and large widths of different heights and/or lengths.

In some embodiments, a dynamic interbody device or dynamic interbody devices may not allow coupled axial rotation and lateral bending of vertebrae adjacent to the dynamic interbody device or dynamic interbody devices. For example, in an embodiment, the curvature of ridges in the first member and second member of the dynamic interbody device only allows for axial rotation of vertebrae adjacent to the dynamic interbody device without allowing for lateral bending. The interaction of the first member with the second member allows for axial rotation and resists at least a portion of the shear load applied by the vertebrae to the dynamic interbody device. In an embodiment, the curvature of ridges in the first member and the second member allow for lateral bending of vertebrae adjacent to the dynamic interbody device without allowing for axial rotation. The interaction of the first member with the second member allows for lateral bending and resists at least a portion of the shear load applied by the vertebrae to the dynamic interbody device.

In some embodiments, a single dynamic interbody device may be used. FIG. **14** depicts a perspective view of dynamic interbody device **50** emphasizing the anterior side and the superior surface. Dynamic interbody device **50** is shown with some axial rotation and lateral bending from a neutral position. Dynamic interbody device **50** may be placed in a disc space between two vertebrae using an anterior approach. The width of the dynamic interbody device may be greater that one half the width of the vertebrae the dynamic interbody device is to be positioned between. The width of the dynamic interbody device may be substantially the same as the width of the vertebrae the dynamic interbody device is to be positioned between. Dynamic interbody device **50** may include first member **56**, second member **58**, and third member **60**. Dynamic interbody device **50** may be a bilateral device with coupled axial rotation and lateral bending. First member **56** may be coupled to second member **58** so that dynamic interbody device **50** accommodates lateral bending and axial rotation of vertebrae coupled to dynamic interbody device **50**. As with a natural functional spinal unit, dynamic interbody device **50** couples lateral bending and axial motion together so that lateral bending motion causes axial rotation, and axial rotation causes lateral bending. Third member **60** may be coupled to second member **58** so that dynamic interbody device **50** accommodates flexion and extension of vertebrae coupled to the dynamic interbody device.

The superior surface may be coupled to an upper vertebra of the vertebrae to be stabilized. An inferior surface of the dynamic interbody device may be coupled to the lower vertebra of the vertebrae to be stabilized. At least a portion the superior surface may be positioned near the edge of the endplate of the upper vertebra so that the dynamic interbody device abuts strong, supportive bone of the upper vertebra. At least a portion of the inferior surface may be positioned near the edge of the endplate of the lower vertebra so that the dynamic interbody device abuts strong, supportive bone of the lower vertebra.

FIG. **15** depicts a side view of first member **56** and FIG. **16** depicts a top view of the first member. First member **56** may include ridges **100** and pin opening **102**. Ridges **100** and the grooves between the ridges may mate with corresponding grooves and ridges of the second member so that the dynamic interbody device accommodates coupled lateral bending and axial rotation. As depicted in FIG. **16**, ridges **100** may be curved. The curvature allows the dynamic interbody device to accommodate axial rotation. Ridges **100** may be symmetrical about center line **104** of first member **56** so that the dynamic interbody device accommodates the same amount of clockwise axial rotation as counterclockwise axial rotation. In some embodiments, the ridges and grooves may not be symmetrical about the centerline so that the dynamic interbody device allows no or limited axial rotation in a particular direction to accommodate the needs of a patient.

A guide pin may be press fit or otherwise secured in pin opening **102** after the second member is coupled to first member **56**. The guide pin may fit in a guide recess in the second member. The guide pin may limit the amount of lateral bending and axial rotation allowed by the dynamic interbody device and/or inhibit separation of first member **56** from the second member. In some embodiments, the first member may have a guide recess and a guide pin may positioned in the second member may reside in the guide recess.

As seen in FIG. **15**, first member **56** may include one or more undercut surfaces **106**. Undercut surfaces **106** may inhibit separation of the second member from first member **56** when the second member is coupled to the first member. Undercut surfaces **106** may share a portion of the load applied to the dynamic interbody device.

FIG. **17** depicts a front view of first member **56**. First member **56** may decrease in height from a position at or near the right side of the first member to the center of the first member. The first member **56** may increase in height from the center to a position near or at the left side of the first member. At least a portion of first member **56** has a concave shape. The concave shape of at least a portion of first member **56** may allow the dynamic interbody device to accommodate lateral bending of vertebrae coupled to the dynamic interbody device.

FIG. **18** depicts a side view of second member **58**. The bottom of second member **58** may include ridges **108**, one or more undercut surfaces **110**, and guide recess **112**. Ridges **108** may be curved and the bottom of second member **58** may have a convex shape so that the ridges of the second member mate with the grooves between the ridges of the first member, and the ridges of the first member mate with the grooves between the ridges of the second member. Undercut surfaces **110** may interact with the undercut surfaces of the first member to inhibit separation of second member **58** from the first member when the dynamic interbody device is assembled. An end of the guide pin placed in the pin opening of the first member may reside in guide recess **112** of second member. The guide pin may limit the range of motion for axial rotation and lateral bending of the assembled dynamic interbody device and inhibit separation of the first member from second member **58**.

Second member **58** may include bearing **82**. Bearing **82** may fit in a recess in the third member so that the assembled dynamic interbody device is able to accommodate flexion and/or extension of vertebrae coupled to the dynamic interbody device. Other connection systems between the second member and the third member that accommodate flexion/extension of vertebrae coupled to the dynamic interbody device may also be used.

In some embodiments, the second member includes a bearing recess and the third member includes a bearing that fits in the recess. Bearing **82** may be located towards a posterior end of the dynamic interbody device. Locating bearing **82** near the posterior end of the dynamic interbody device locates the axis of rotation for flexion/extension close to the natural axis of rotation for flexion/extension of the vertebrae. The curvature of bearing **82** may be relative small to limit translational movement of the third member relative to second member during flexion/extension.

FIG. **19** depicts a top surface of second member **58**. Second member **58** may include slots **114**. Tabs of the third member may be positioned in slots **114**. One or more pins positioned in bearing **82** of second member **58** and through the tabs of the third member may couple the second member to the third member. When the dynamic interbody device is positioned between vertebrae, fluid may enter the slots and keep the dynamic interbody device lubricated.

In some embodiments, the second member of the dynamic interbody device may have a protrusion and the first member may have a complementary slot instead of a plurality of complementary ridges and grooves. In some embodiments, the second member of the dynamic interbody device may have a slot and the first member may have a complementary protrusion instead of a plurality of complementary ridges and grooves in the second member and the first member.

FIG. **20** depicts a perspective view of third member **60** that emphasizes a bottom surface of the third member. Third member **60** may include recess **116** and tabs **118**. Recess **116** may be complementary to the bearing of the second member so that the assembled dynamic interbody device allows for flexion/extension of vertebrae coupled to the dynamic interbody device. Tabs **118** may be positioned in the slots of the second member. A pin or pins positioned through openings **120** in tabs **18** may couple third member **60** to the second member.

In some embodiments, the front faces of the first member, second member and/or third member may include indentions, openings, or other surface features for connecting the dynamic interbody device to an inserter. The connection between the dynamic interbody device and the inserter allows force to be applied substantially evenly to the dynamic interbody device to facilitate insertion of the dynamic interbody device into the disc space. The inserter may maintain the position of the first member relative to the second member and the third member during insertion.

The ridges of the first member are complementary to the ridges of the second member. When the dynamic interbody device is positioned between vertebrae, the vertebrae exert compressive and/or shear forces on the dynamic interbody device. Having a number of ridges increases the surface area for dissipating force applied to the dynamic interbody device. Increasing the surface area for dissipating force applied to the dynamic interbody device may reduce pressure and decrease wear of the dynamic interbody device.

A front part of the third member may rotate towards the second member to accommodate flexion. The front part of the third member may rotate away from the second member to accommodate extension.

FIG. **21** depicts an embodiment of dynamic posterior stabilization system **122**. Dynamic posterior stabilization system **122** may include closure members **124**; first bone fastener **126**; second bone fastener **128**; elongated member **130**; bias members **132**, **134**; and stop **136**. In some embodiments, first bone fastener **126** is positioned in the upper vertebra of the vertebrae to be stabilized. In other embodiments, first bone fastener is positioned in the lower of the vertebrae to be stabilized.

When closure member **124** couples elongated member **130** to first bone fastener **126**, movement of the elongated member relative to the first bone fastener may be inhibited. When closure member **124** couples elongated member **130** to second bone fastener **128**, translational and/or rotational movement of the elongated member relative to the second bone fastener may be possible. The ability to have translational movement of elongated member **130** relative to second bone fastener **128** may allow dynamic posterior stabilization system **122** to accommodate flexion, extension and lateral bending of a first vertebra coupled to the dynamic posterior stabilization system relative to a second vertebra coupled to the dynamic posterior stabilization system. The ability to have rotational movement of elongated member **130** relative to second bone fastener **128** may allow dynamic posterior stabilization system **122** to accommodate axial rotation of the first vertebra coupled to the dynamic posterior stabilization system relative to the second vertebra coupled to the dynamic posterior stabilization system.

FIG. **22** depicts an embodiment of closure member **124**. Closure member **124** may couple the elongated member of the dynamic posterior stabilization system to the first bone fastener or to the second bone fastener. Closure member **124** may include threading **138** or other structure that secures the closure member to a collar of the first bone fastener **126** or to a collar of the second bone fastener. Closure member **124** may include tool opening **140**. A portion of a driver may be inserted into tool opening **140** to facilitate attaching closure member **124** to the collar of the first bone fastener or to the collar of the second bone fastener.

Closure members may be other types of fasteners, including but not limited to clips and snap on connectors. In some embodiments, the closure member coupled to the first bone fastener may be different from the closure member coupled to the second bone fastener. For example, the closure member used to secure the elongated member to the first bone screw may be a closure member as depicted in FIG. **22**, while a closure member used to couple the elongated member to the second bone fastener may be a clip that allows the elongated member to move relative to the second bone fastener.

As shown in FIG. **21**, dynamic posterior stabilization system **122** includes elongated member **130**. Elongated member **130** may be a rod, bar, plate, combination thereof, or other type of member coupled to first bone fastener **126** and second bone fastener **128**. In some embodiments where the dynamic posterior stabilization system is to be used with a dynamic interbody device, elongated member **130** may be bent so that the elongated member has a curvature that facilitates the use of the dynamic posterior stabilization system in conjunction with the dynamic interbody device. In embodiments where the dynamic posterior stabilization system is not used in conjunction with a dynamic interbody device, the elongated member may be straight or curved. Elongated members with appropriate curvature may be included in the instrument kit for the spinal stabilization procedure.

FIG. **23** depicts an embodiment of bent elongated member **130**. In an embodiment, a portion of elongated member **130** near first end **142** is secured to the first bone fastener of the dynamic posterior stabilization system so that movement of the elongated member relative to the first bone fastener is inhibited. A portion of elongated member **130** near second end **144** may be coupled to the second bone fastener of the dynamic posterior stabilization system so that translational movement and or rotational movement of the elongated member relative to the second bone fastener is allowed. In some embodiments, concave portion **146** of elongated member **130** may be oriented to face the vertebrae coupled to the dynamic posterior stabilization system. In some embodiments, a portion of elongated member **130** near second end **144** may be bent so that the elongated member does not contact or approach a vertebra during patient movement.

As shown in FIG. **21**, an end of elongated member **130** near second bone fastener **128** may include stop **136**. Stop **136** may retain bias member **134** on elongated member **130**. In some embodiments, the position of stop **136** may be adjustable along the length of the elongated member. A fixed position stop or an adjustable position stop may be used in conjunction with bias member **132** instead of using the collar of first bone fastener **126** as the stop for bias member **132**. In some embodiments, a removable stop may initially maintain bias member **132** in compression. In some embodiments, a removable stop may initially maintain bias member **132** in compression. The removable stops may facilitate coupling elongated member **130** to second bone fastener **128**. After elongated member **130** is coupled to second bone fastener **128**, the removable stops may be removed so that the bias members can accommodate movement of the elongated member relative to the second bone fastener caused by flexion/extension and/or lateral bending. In some embodiments, an insertion instrument may hold bias members **132**, **134** in compression when elongated member **130** is being coupled to first bone fastener **126** and second bone fastener **128**.

Bias members **132**, **134** may surround or partially surround elongated member **130**. Bias members **132**, **134** may be stacks of elastic washers, elastic tubes, springs, or other systems that provide resistance to compression. In some embodiments, bias members **132**, **134** may be formed of biocompatible polymeric material. For example, bias members **132**, **134** may be formed of silicone-urethane co-polymer.

Bias members **132**, **134** may transmit little or no force to second bone fastener **128** when dynamic posterior stabilization system **122** is in a neutral position. If second bone fastener **128** is coupled to the more caudal vertebra of the vertebrae to be stabilized, compression of bias member **132** may accommodate translational movement of elongated member **130** caused by extension and/or lateral bending of the vertebrae coupled to dynamic posterior stabilization system **122**. If second bone fastener **128** is coupled to the more caudal vertebra of the vertebrae to be stabilized, compression of bias member **134** may accommodate translational movement of elongated member **130** caused by flexion and/or lateral bending of the vertebrae coupled to dynamic posterior stabilization system **122**.

Bias member **132** may accommodate up to about 3 mm of travel of second bone fastener **128** towards first bone fastener **126**. Bias member **134** may accommodate up to about 2 mm of travel of second bone fastener **128** away from first bone fastener **126**.

In some embodiments, bias member **132** and bias member **134** are the same. For example, bias members **132**, **134** may be stacks of washers. In some embodiments, bias member **132** is different than bias member **134**. For example, bias member **132** is a spring, and bias member **134** is an elastic tube.

Bias members **132**, **134** may allow dynamic posterior stabilization system **122** to provide stability while still allowing for anatomical motion and dynamic resistance that mimics normal segmental stiffness of the spine. Knowledge of the elastic properties (e.g., the amount of compression per degree of rotation) of the material chosen for bias members **132**, **134** allows the length of the bias members placed on the elongated member to be selected so that the dynamic posterior stabilization system provides a desired amount of resistance. FIG. **24** depicts a plot of the applied moment versus the amount of rotation for an intact (normal) functional spinal unit (plot **148**), for an unconstrained functional spinal unit (plot **150**), and for a functional spinal unit with a dynamic posterior stabilization system (plot **152**). The slope of the curves at each point represents spinal stiffness. The neutral zone is the low stiffness region of the range of motion. The dynamic posterior stabilization system may allow for stabilization of the spine while providing substantially unconstrained motion within the neutral zone and increasing resistance to rotation within the elastic zone. The stiffness of vertebrae supported by the dynamic posterior stabilization system may closely mimic the stiffness of a normal functional spinal unit. The behavior of the dynamic posterior stabilization system may closely mimic the normal kinematics of the functional spinal unit.

FIG. **25** depicts the components of an embodiment of first bone fastener **126**. First bone fastener **126** may include fastener **154**, collar **156**, and saddle **158**. Fastener **154** may include shaft **160** and head **162**. Shaft **160** may secure first bone fastener **126** to bone (e.g. a vertebra). Shaft **160** may include threading **164** that secures the shaft to the bone.

A portion of outer surface **166** of head **162** may have a spherical contour complementary to a portion of spherically contoured inner surface **168** of collar **156**. The shape of outer surface **166** and inner surface **168** of collar **156** may allow for polyaxial positioning of the collar relative to fastener **154**. Inner surface **170** of head **162** may be spherically contoured. The spherical contour of inner surface **170** may allow saddle **158** to be positioned in fastener **154** at a desired angle to accommodate the position of collar **156** relative to the fastener.

Collar **156** may include arms **172** and lower body **174**. A portion of the elongated member may be positioned in the slot between arms **172**. A portion of the inner surfaces of arms **172** may include threading **176** that is complementary to threading of the closure member used to secure the elongated member to first bone fastener **126**. Portion **168** of the inner surface of lower body **174** may have a spherically contoured section that complements the spherical contour of outer surface **166** of fastener head **162** to allow for polyaxial positioning of collar **156** relative to fastener **154**.

Head **162** of fastener **154** may be positioned in collar **156** to form a fastener and collar combination. FIG. **26** depicts a top view of fastener and collar combination **178**. When head **162** is positioned in collar **156**, separation of the fastener from the collar may be difficult. Several fastener and collar combinations **178** may be provided in an instrument kit for a dynamic spinal stabilization procedure. The instrument kit may include several combinations **178** with fasteners **154** of varying lengths. For example, the kit may include fastener and collar combinations with fastener having lengths from about 30 mm to about 75 mm in 5 mm increments. In some embodiments, collar **156** of each combination **178** is stamped, printed or etched with the length of fastener **154**. Fasteners **154** and/or collars **156** of combinations **178** in the instrument kit may be color coded to indicate the length of the fasteners. For example, the collars of all combinations in the instrument kit with fasteners **154** that are about 30 mm in length have an orange color, the collars of all combinations in the instrument kit with fasteners that are about 35 mm in length have a yellow color, and the collars of all combinations with fasteners that are about 40 mm in length have a green color. Additional colors may be used for additional sizes.

Fastener **154** may include tool opening **180**. Tool opening **180** may complement a head of a driver. The driver may be used to insert fastener **154** into bone. The driver may be included in the instrument kit for the spinal stabilization procedure. In some embodiments, arms **172** may include flats, recesses or openings that engage insertion tools or guides.

Referring to FIG. **25**, saddle **158** may have post **182** and support **184**. Saddle **158** may be positioned in fastener **154** after the fastener and collar combination has been inserted into a vertebra. Post **182** may be positioned in fastener **154**. Post **182** may be angled within head **162** of fastener **154** so that saddle **158** can accommodate polyaxial positioning of collar **156** relative to the fastener. In some embodiments, a retaining ring inhibits separation of saddle **158** from fastener **154**.

Support **184** may include groove **186**. A portion of the elongated member of the dynamic posterior stabilization system may be positioned in groove **186**. In some embodiments, saddle **158** and/or collar **156** are shaped so that groove **186** aligns with the slot formed between arms **172** of collar **156** when the saddle is placed in the collar.

A portion of the elongated member may be positioned in groove **186**. The closure member for first bone fastener **126** may be threaded on collar **156** and tightened against elongated member **130**. In some embodiments, the closure member may include one or more points or edges that bite into the elongated member when the closure member is tightened against the elongated member. When the closure member is tightened against the elongated member, the position of collar **156** relative to fastener **154** may become fixed, and movement of the elongated member relative to first bone fastener may be inhibited.

FIG. **27** depicts an embodiment of second bone fastener **128**. Second bone fastener **128** may include fastener **154**, collar **156**, saddle **158**, and cover **188**. Fastener **154**, collar **156**, and saddle **158** of second bone fastener **128** may be substantially the same as the fastener, collar and saddle of the first bone fastener. Cover **188** may include groove **190**.

Saddle **158** may be positioned in collar **156** after the fastener and collar combination are inserted into a vertebra. A portion of the elongated member may be positioned in groove **186** of saddle **158**. Cover **188** may be positioned on top of the elongated member. The radius of groove **190** may be larger than the radius of the portion of the elongated member positioned in the groove. The closure member for second bone fastener **128** may be threaded on collar **156** and tightened against cover **188**. In some embodiments, the closure member may include one or more points or edges that bite into cover **188** when the closure member is tightened against the cover. The position of collar **156** relative to fastener **154** may become fixed when the closure member is tightened against cover **188**. Having the radius of groove **190** larger than the radius of the portion of the elongated member positioned in the groove may allow translational movement and/or rotational movement of the elongated member relative to second bone fastener **128** when the closure member couples the elongated member to the second bone fastener.

When a closure member secures the elongated member between saddle **158** and cover **188**, significant change in height of the elongated member relative to second bone fastener **128** may be inhibited. Inhibiting height change of the elongated member relative to second bone fastener may allow the dynamic posterior stabilization system to share a portion of the shear load applied to a dynamic interbody device or intervertebral disc between the vertebrae being stabilized.

In some embodiments, a bridge may be coupled to a bone fastener of the dynamic posterior stabilization system. FIG. **28** depicts an embodiment of bridge **192**. Bridge **192** may include connector **194**, and end **196**. Connector **194** may be coupled to the bone fastener inserted into the lower vertebra of the vertebrae being stabilized. Coupling bridge to the lower vertebra may inhibit contact of the bridge with neural structures exiting the vertebrae. End **196** may contact the dynamic interbody device positioned between vertebrae during use to inhibit posterior migration and/or backout of the dynamic interbody device from the disc space.

In some dynamic posterior stabilization system embodiments, the elongated member may be positioned lateral to the first bone fastener and/or the second bone fastener. FIG. **29** depicts a top view representation of an embodiment of dynamic posterior stabilization system **122** where elongated member **130** is positioned lateral to second bone fastener **128**. A closure member may secure elongated member **130** to first bone fastener **126** so that movement of the elongated member relative to the first bone fastener is inhibited.

Second bone fastener **128** may include member **198**. A portion of member may slide over or into a portion of collar **156** of second bone fastener **128**. The connection between the collar and member may inhibit rotation of member **198** relative to collar **156**. A closure member may secure member **198** to collar **156** and second bone fastener **128**. When the closure member secures member **198** to collar **156** movement of second bone fastener **128** relative to elongated member **130** is allowed. Second bone fastener **128** may be able to move axially relative to elongated member **130** to accommodate flexion/extension and/or lateral bending of vertebrae coupled to the dynamic posterior stabilization system. Second bone fastener **128** may also be able to rotate relative to elongated member **130** to accommodate axial rotation of vertebrae coupled to the dynamic posterior stabilization system.

FIG. **30** depicts a front view of a portion of second bone fastener **128** of FIG. **29** with member **198** coupled to collar **156** of the second bone fastener. Member **198** may include slot **200**. A portion of elongated member **130** may pass through slot **200**. Slot **200** and/or the portion of elongated member **130** that can pass through slot may have cross sectional shapes that accommodate rotation of second bone fastener **128** relative to the elongated member so that the dynamic posterior stabilization system is able to accommodate axial rotation of vertebrae being stabilized. Second bone fastener **128** may also be able to move axially along elongated member **130** so that the dynamic posterior stabilization system can accommodate flexion/extension and/or lateral bending of vertebrae being stabilized.

Placement of the elongated member adjacent to the second bone fastener may allow for construction of a multi-level dynamic posterior stabilization system. FIG. **31** depicts a multi-level dynamic posterior stabilization system that includes dynamic posterior stabilization system **122'** and dynamic posterior stabilization system **122"**. Elongated member **130"** of dynamic posterior stabilization system **122"** may be positioned in and secured to the collar of second bone fastener **128'** of dynamic posterior stabilization system **122'**. A mirror image dynamic posterior stabilization system construction may be installed on the contralateral side of the spine.

In some dynamic posterior stabilization system embodiments, the elongated member may be at a substantially fixed height relative to the second bone fastener. In some dynamic posterior stabilization system embodiments, the elongated member may angulate so that the height of the elongated member relative to the second bone fastener is variable. Allowing the height of the elongated member relative to the second bone fastener to vary may allow for the use of a straight elongated member with a dynamic interbody device. FIG. **32** depicts a top view representation of an embodiment of dynamic posterior stabilization system **122**. Dynamic posterior stabilization system **122** may include first bone fastener **126**, second bone fastener **128**, elongated member **130**, and bias members **132**, **134**. Elongated member **130** may include threaded portion **204**. Second bone fastener **128** may include member **198**. Member **198** may allow elongated member **130** to be positioned lateral to the fastener of second bone fastener **128**. Lateral placement of the elongated member may allow for the establishment of multi-level stabilization systems. The elongated member of a second dynamic posterior stabilization system may couple to the collar of the second bone fastener of the first dynamic posterior stabilization system. In some embodiments, the member may position the elongated member through the collar of the second bone fastener.

FIG. **33** depicts a front view representation of a portion of second bone fastener **128**. Member **198** may include slot. Slot **200** may allow for change in vertical position of elongated member **130** relative to second bone fastener **128**. Change in vertical position of elongated member **130** relative to second bone fastener **128**, along with the compression of one the bias members, may allow the dynamic posterior stabilization system to accommodate flexion or extension of vertebrae coupled to the dynamic posterior stabilization system.

The portion of elongated member **130** positioned in slot **200** may have one or more flats. For example, elongated member **130** may have a hexagonal portion. The flats may interact with member **198** to inhibit rotation of elongated member **130** relative to second bone fastener **128** while still allowing for changes in vertical position of the elongated member relative to the second bone fastener. Elongated member **130** may be able to rotate relative to the first bone fastener so that the dynamic posterior stabilization system is able to accommodate axial rotation of a first vertebra coupled to the first bone fastener relative to a second vertebra coupled to the second bone fastener.

FIG. **34** depicts a side view representation of a portion of dynamic posterior stabilization system **122** with a portion of first bone fastener **126** depicted in cutaway to emphasize the interior of the first bone fastener. Ball **206** may be threaded on threaded portion **204** of elongated member **130**. Ball **206** may be positioned in collar **156** of first bone fastener **126**. Ball **206** may allow elongated member **130** to be pivotably coupled to first bone fastener **126**. Closure member **208** for first bone fastener **126** may include a spherically shaped portion that complements a portion of the outer surface of ball **206**. In some embodiments, the collar of the second bone fastener may accept a closure member that is identical to closure member **208** for first bone fastener **126** to avoid the need for different types of closure members for the first bone fastener and the second bone fastener.

In some embodiments, one or more lock rings may be placed on the threaded end of the elongated member. After the position of the ball is adjusted so that the elongated member will fit in the first bone fastener and the second bone fastener, one or more lock rings may be positioned against the ball to inhibit rotation of the ball relative to the elongated member. In some embodiments, an adhesive may be used to inhibit change in position of the ball relative to the elongated member after the position of the ball is set. Other systems may also be used to inhibit change in position of the ball relative to the elongated member after the position of the ball is set. In some embodiments, a portion of the end of the elongated member may be removed after the position of the ball is set so that there is little or no extension of the end of the elongated member beyond the collar of the first bone fastener when the dynamic posterior stabilization system is assembled.

In some embodiments, the ball may be at a fixed position on the elongated member. The length of the elongated member may be adjustable to allow the elongated member to be positioned in the first bone fastener and the second bone fastener. In an embodiment, a first portion of the elongated member may move relative to a second portion of the elongated member. A setscrew or other fastener may fix the position of the first portion relative to the second portion. Having a fixed position of the ball allows little or no extension of the end of the elongated member beyond the collar of the first bone fastener.

When closure member **208** is secured to collar **156** of first bone fastener **126**, the closure member and the collar may allow rotation of ball **206** relative to the first bone fastener. Rotation of ball **206** allows for rotation and/or angulation of elongated member **130** relative to first bone fastener **126**.

Closure member **208**, collar **156** and ball **206** may allow for angulation of elongated member **130** relative to first bone fastener **126**. The angular movement of elongated member **130**, along with compression of bias member **132** or bias member **134**, allows dynamic posterior stabilization system **122** to accommodate flexion/extension and/or lateral bending of the vertebrae coupled to the dynamic posterior stabilization system.

Elongated member assemblies may be provided in the instrument kit for the spinal stabilization procedure. The elongated member assemblies may include elongated member **130**; ball **206** threaded on the elongated member; member **198**; bias members **132**, **134**; and stops **136**. During an installation procedure, the fastener of the first bone fastener **126** and the fastener of second bone fastener **128** may be positioned in the vertebrae to be stabilized. Bridge **192** may be positioned between the collar of second bone fastener **128** and the vertebra to which the second bone fastener is attached. Bridge **192** may be secured to the vertebra by the collar of the second bone fastener.

The position of ball **206** on elongated member **130** may be adjusted by rotating the ball relative to the elongated member until the position of the ball on the elongated member allows the ball to be positioned in collar **156** of first bone fastener **126** when member **198** is positioned in the collar of second bone fastener **128**. Member **198** may be coupled to the collar of the second bone fastener and ball **206** may be positioned in collar **156** of first bone fastener **126**. Closure member **208** may be used to secure member **198** to second bone fastener **128**. Closure member **208** may be used to couple ball **206** to collar **156** of first bone fastener **126**.

In some embodiments, a first dynamic posterior stabilization system coupled to vertebrae may be unconnected to a second dynamic posterior stabilization system on a contralateral side of the vertebrae. In some embodiments, one or more transverse connectors may connect dynamic posterior stabilization systems placed on contralateral sides of vertebrae.

FIG. **35** depicts a representation of dynamic interbody device **50** and posterior stabilization system **122** positioned between vertebrae **52**, **54**. Bridge **192** may be coupled to second bone fastener **128** of dynamic posterior stabilization system **122**. Coupling dynamic interbody device **50** to dynamic posterior stabilization system **122** may inhibit undesired migration of the dynamic interbody device relative to vertebrae **52**, **54** while still allowing for flexion, extension, lateral bending, and/or axial rotation of the vertebrae.

When closure member **124** is tightened in collar **156** of second bone fastener **128**, a bottom surface of the collar may align and be tightened against bridge **192**. Tightening closure member **124** may fix the position of bridge **192**. When closure member **124** is tightened so that the bottom of collar **156** is positioned against bridge **192**, the center of curvature of elongated member **130** may align or substantially align with the center of curvature of dynamic interbody device **50** that allow for flexion/extension and/or lateral bending. Aligning or substantially aligning the center of curvature of elongated member **130** with the center or centers of curvature of dynamic interbody device **50** allows the elongated member to move relative to second bone fastener **128** during flexion/extension and/or lateral bending so that dynamic posterior stabilization system **122** works in conjunction with the dynamic interbody device.

Dynamic posterior stabilization system **122** may share a portion of the load applied to the vertebrae **52**, **54** while providing guidance and resistance to flexion/extension and/or lateral bending that is, or is approximate to, the resistance provided by a normal functional spinal unit. Allowing for movement of the dynamic interbody device and for movement of the dynamic posterior stabilization system may inhibit deterioration of adjacent functional spinal units.

In some embodiments, first bone fastener **126** of dynamic posterior stabilization system is placed in the lower (more cephalad) of the vertebrae to be stabilized. Bridge **192** may couple dynamic interbody device **50** to dynamic posterior stabilization system **122**. Bridge may be coupled to dynamic posterior stabilization system **122** at or near to second bone fastener **128**. Coupling bridge **192** to dynamic posterior stabilization system **122** at or near to second bone fastener **128** may inhibit or eliminate contact of the bridge with neural structure exiting from between the vertebrae.

In some embodiments, a posterior approach may be used to install a stabilization system for a patient. The stabilization system may replace one or more parts of a functional spinal unit of the patient. The stabilization system may include one or more dynamic interbody devices, and one or more dynamic posterior stabilization systems.

During some posterior insertion procedures, the facet joints at the operative level may be removed (e.g., the superior facets from lower vertebra and the inferior facets from the upper vertebra). In some embodiments, the spinous process of the upper vertebra may also be removed. A bone awl may be used to mark each of the pedicles where the bone fasteners are to be positioned. A pedicle probe may be used to widen the initial holes made by the bone awl and set a desired trajectory. A tap may be attached to a handle and inserted into one of the pedicles. After insertion, the handle may be removed leaving the tap extending from the pedicle. The handle and the tap may have an AO connection or other type of low profile connection system. A tap may be inserted in each of the four pedicles. The taps may remain in the pedicles. Initially, the taps may be used to maintain distraction during a discectomy to provide disc space for the dynamic interbody devices. FIG. **36** depicts taps **210** positioned in lower vertebra **54**, with the handle removed from the taps. Taps **210** may be positioned at any desired angle into lower vertebra **54** and the upper vertebra.

After a discectomy, two expandable trials may be inserted in the disc space between the vertebrae. The expandable trial used on the left side of the patient may be a mirror image of the expandable trial used on the right side of the patient. FIGS. **37-39** depict an embodiment of expandable trial **212** that may be positioned on a first side of the vertebrae. Each expandable trial may include body **214**, rotator **216**, scale **218**, base plate **220** and movable plate **222**. Rotator **216** may be located at an end of body **214**. Scale **218** may be located in an upper portion of body **214**.

A rotatable handle may be coupled to rotator **216**. When rotator **216** is turned, movable plate **222** moves in or out relative to base plate **220**. FIG. **38** depicts movable plate **222** extended away from base plate **220**. The amount of movement of movable plate **222** relative to base plate **220** may be indicated by the change in position of a movable portion of scale **218** relative to a stationary portion of the scale. The movable portion may include numbers and markings that indicate the height of a corresponding dynamic interbody device. The marking and corresponding number that aligns with a marking of the stationary portion of the scale indicates the current separation height of movable plate **222** relative to base plate **220**.

A middle portion of body **214** may include passage **224**, keyway **226**, and guide recess **228**. A drill or other type of cutter may be positioned through passage **224** to form a groove in the lower vertebra to accommodate a keel of the dynamic interbody device to be positioned in the disc space between the vertebrae. Keyway **226** may ensure that only the proper instrument guide can be used in association with the particular expandable trial. Guide recess **228** may accept an end of a guide release of the proper guide.

Base plate **220** may have an inferior surface with a shape that is substantially the same as the shape of the inferior surface of the dynamic interbody device to be positioned between the vertebrae. Base plate **220** may be positioned against the lower vertebra of the vertebrae being stabilized. Movable plate **222** may have a superior surface with a shape that is substantially the same as the shape of the superior surface of the dynamic interbody device to be positioned between the vertebrae. When the expandable trial is in an initial position, the movable plate and the base plate have a height that allows for insertion in the disc space between the vertebrae. After insertion, the rotator may be turned to separate the movable plate from the base plate to position the base plate against the lower vertebra and the movable plate against the upper vertebra.

The base plate and movable plate of the expandable trials may be positioned in the disc space between the vertebrae. An engaging end of a handle may be inserted in the rotator of a first expandable trial. The handle may be turned to cause the movable plate to move away from the base plate so that the movable plate and the base plate contact the vertebrae. The handle may be used to rotate the rotator of the second expandable trial so that the movable plate and the base plate of the second expandable trial contact the vertebrae. The separation height between the base plate and the movable plate is indicated by the scale of the expandable trial.

Guides may be coupled to each expandable trial. FIGS. **40-42** depict an embodiment of guide **230**. Guide **230** may include passageway **232**, guide release **234**, passage **236**, and recess **238**. Passageway **232** may include key **240**. Passageway **232** is shaped to fit over the body of the proper expandable trial. The key of the proper expandable trial fits in keyway **240**. Passage **236** accepts posts of a bridge that couples the first expandable trial to the second expandable trial. Recess **238** accommodates a stabilizer of the bridge.

Guide release **234** may include grip **242**, body **244**, and end **246**. When grip **242** is pulled outward from the guide **230**, the grip may be rotated relative to body **244**. In a first position (depicted in FIG. **41**), end **246** of guide release extends into passageway **232**. Arms **248** of grip **242** are next to flats **250** of body **244**. A spring or other bias member in guide release **234** drives end **246** into passageway **232**. In a second position (depicted in FIG. **42**), end **246** does not extend into passageway **232**. Grip **242** is pulled away from passageway **232** and rotated so that arms **248** of the grip reside on the top of body **244**. The second position may be used to facilitate removal of an expandable trial or insertion instrument from guide **230**.

A first guide may be placed over the appropriate expandable trial and lowered until the key of the guide is in the keyway of the expandable trial and the end of the guide release inhibits further movement of the guide. The grip may be pulled outwards to withdraw the end of the guide release from the passageway. The guide may be lowered and the grip may be released so that the spring in the guide release forces the end of the guide release against the body of the expandable trial. The guide may be lowered until the end of the guide release extends into the guide recess of the expandable trial. A second guide may be placed over the other expandable trial. Attaching the guides to the expandable trials after insertion of the base plates and movable plates between the vertebrae may allow more visibility of the position of the base plates and movable plates of the expandable trials during insertion. During some dynamic interbody device insertion procedures, the guide for the first expandable trial and/or the guide for the second expandable trial is placed on the appropriate expandable trial before the base plate and movable plate of the expandable trial is positioned between the vertebrae.

The position of the expandable trials may be adjusted so that the passages of the guides are oriented vertically. Also, an end of the base plate of the first expandable trial may touch or be close to touching an end of the base plate of the second expandable trial. In some embodiments, the base plates of the expandable trials may be coupled together with male and female portions when the base plates are positioned between the vertebrae.

Posts of the bridge may be inserted in the passages of the guides. FIG. **43** depicts an embodiment of insertion bridge **252**. Insertion bridge **252** may include handle **254**, posts **256**, and wheel **258**. Handle **254** facilitates positioning and moving insertion bridge **252**. Handle **254** may include slide **260** with threaded opening **262**. Slide **260** may move forward and backward in handle **254**. Posts **256** may fit within passages of the guides. Wheel **258** may extend or retract stabilizers **264**. Stabilizers **264** may extend from the body of insertion bridge **252** into the recesses of the guides. FIG. **44** depicts stabilizers **264** extended from the body of insertion bridge **252**. When the stabilizers **264** are extended against the recesses of the guides, the outward force applied by the stabilizers to the guides generates torque applied by the guide to posts **256**. The outward force and the torque couple the guides to insertion bridge **252** so that the guides remain coupled to the bridge when the expandable trials are removed from the guides.

FIG. **45** depicts insertion bridge **252** coupled to guides **230'**, **230"**. Wheel **258** has been turned to extend the stabilizers into the recesses of the guides and couple guides **230'**, **230"** to insertion bridge **252**.

A bar assembly may be coupled to the slide of the insertion bridge. FIG. **46** depicts bar assembly **266** coupled to insertion bridge **252**. Bar assembly **266** may include base **268**, knob **270**, and rods **272**. A shaft of coupled to knob **270** may extend through base **268**. A threaded end of the shaft may be threaded into the threaded opening in the slide of insertion bridge **252**. Rods **272** may be coupled to the base **268**. Rods **272** may be positioned near taps **210** by sliding the slide relative to handle **254** and/or by rotating rods **272** relative to the taps. When rods **272** are positioned near taps **210**, knob **270** may be tightened against base **268** to inhibit movement of the slide relative to handle **254** and to inhibit rotation of the rods relative to the taps.

Rod connectors may be attached to the taps and to the rods of the bar assembly to anchor the insertion bridge to the spine. FIG. **47** depicts rod connector **274** attached to tap **210** and rod **272**. When tap **210** and rod **272** are snapped into the openings of rod connector **274**, knob **276** of the rod connector may be tightened to secure the taps and rods together. A second rod connector may be used to secure the second tap to the second rod.

The rotatable handle may be inserted into the rotators of the expandable trials and turned to set the expandable trials to the height of the dynamic interbody devices to be placed in the disc space. A keel guide may be inserted in the passage of the first expandable trial. FIG. **47** also depicts keel guide **278** positioned in passage **224** of expandable trial **212'**. FIG. **48** depicts a distal portion of keel guide **278** with drill bit **280** forming a groove in lower vertebra **54**. Base plate **220** of expandable trial includes a concave groove that accommodates drill bit **280**. After the formation of the first keel groove, drill bit **280** and keel guide may be removed from the first expandable trial. The keel guide may be placed in the passage of the second expandable trial. The drill bit may be used to form a second keel groove in the lower vertebra.

The dynamic interbody devices to be inserted between the vertebrae may be attached to the appropriate insertion instruments. FIG. **49** depicts insertion instrument **282'** for the first dynamic interbody device. The insertion instrument for the second dynamic interbody device may be a mirror image of the insertion instrument for the first dynamic interbody device. Insertion instrument **282** may include key **284**, guide recess **286**, wheel **288**, shaft **290**, and ridges **292**. Key **284** and the shape of the body of insertion instrument **282** correspond to the shape of the passageway through the appropriate guide. Guide recess **286** accepts the end of the guide release of the guide to fix the position of insertion instrument **282** relative to the guide.

Wheel **288** may be rotated to rotate shaft **290**. Rotating shaft **290** may advance or retract the shaft relative to the body of insertion instrument **282**. The end of shaft **290** may be threaded. The threaded end may mate with the threaded opening in the appropriate dynamic interbody device. When shaft **290** is threaded to the appropriate dynamic interbody device, ridges **292** reside in the slots of the dynamic interbody device to place the dynamic interbody device in the desired position for insertion (i.e., neutral axial rotation, neutral lateral bending, and full flexion).

The rotation handle may be attached to the rotator of the first expandable trial. The rotator may be turned to decrease the separation height between the base plate and the movable plate of the expandable trial. The grip of the guide release may be pulled outwards, rotated and released so that the end of the guide release is withdrawn from the passageway of the guide. The first expandable trial may be removed from the guide. The first dynamic interbody device may be placed through the passageway and between the vertebrae. The grip of the guide release may be pulled outwards, rotated and released so that the spring of the guide release tries to force the end of the guide release into the passageway of the guide. The insertion instrument may be driven downwards until the end of the guide release snaps into the guide recess of the insertion instrument. If needed, a mallet or other impact instrument may be used against the insertion instrument to drive the dynamic interbody device between the vertebrae.

The second expandable trial may be removed from the guide. The second dynamic interbody device may be inserted between the vertebrae. FIG. **50** depicts instrument inserters **282** and dynamic interbody devices **50'**, **50"** positioned against lower vertebrae **54**. Imaging techniques may be used to determine that the dynamic interbody devices are properly interconnected and positioned in the disc space. When the dynamic interbody devices are properly interconnected and positioned, wheels **288** of insertion instruments **282'**, **282"** may be rotated to disconnect the insertion instruments from dynamic interbody devices **50'**, **50"**. Grips **242** of guides **230** may be pulled outwards to retract the ends of the guide releases from the passageways of the guides, and insertion instruments **282'**, **282"** may be removed from the guides. Rod connectors **274** may be removed from taps **210** and bars **272**. Insertion bridge **252**, with bar assembly **266** and guides **230**, may be removed.

Taps **210** may be removed from the vertebrae and bone fasteners of dynamic posterior stabilization systems may be inserted in the openings where the taps where positioned. Elongated members may be coupled to the bone fasteners to form dynamic posterior stabilization systems on each side of the vertebrae.

In some embodiments, another technique may be used to insert dynamic interbody devices between vertebrae. An insertion structure may be formed before positioning an expandable trial or expandable trials between the vertebrae. Taps may be inserted in each of the pedicles. FIG. **36** depicts taps **210** positioned in lower vertebra **54**, with the handle removed from the taps. Taps **210** may be positioned at any desired angle into lower vertebra **54** and the upper vertebra.

After a discectomy, one or more trials may be positioned in and removed from the disc space on a first side and a second side of the vertebrae. The trials may have the same length and width profile as the first member of the dynamic interbody device to be placed in the disc space or the same length and width profile as the third member of the dynamic interbody device to be placed in the disc space. The lengths and widths of the dynamic interbody devices to be placed in the disc space may be determined based on the trials.

During some insertion procedures, the position of lower vertebra **54** is used as the basis for establishing the insertion angles for the dynamic interbody devices. A support frame may be coupled to taps **210**. FIG. **51** depicts support frame **294** coupled to taps **210**. Support frame **294** may include rod connectors **274**, bar assembly **266**, and bridge assembly **298**. Bar assembly **266** may include a shaft with a threaded end, hub **268**, knob **270**, and rods **272**. Rods **272** may be directly connected to hub **268** so that rotation of the rods independent of the hub is inhibited.

Rod connectors **274** may be used to couple bar assembly **266** to taps **210**. Tap connectors **274** have sufficient freedom of movement to allow bar assembly **266** to be positioned at a desired height above the vertebrae with a horizontal orientation and with the vertical center line of the bridge assembly positioned substantially in line with the vertical center line of the end plate of lower vertebra **54**. Hub **268** may be rotated in a recess in the handle of bridge assembly **298** to allow the front face of the bridge assembly to be oriented substantially parallel to the end plate of lower vertebra **54**. Hub **268** may be moved forward or backward in the recess to adjust the offset distance of the front face of bridge assembly **298** from the end plate of lower vertebra **54**.

Bridge assembly **298** may include handle **254**, slide **260**, guide slots **300**, and guide releases **302**. Handle **254** may be used to move bridge assembly **298**. Slide **260** may be positioned in a hollow portion of handle **254**. Hub **268** of bar assembly **266** may be positioned in a recess in handle **254**. The threaded end of the shaft of bar assembly **266** may be threaded into a threaded opening of slide **260**. When knob **270** of bar assembly **266** is loose, the bar assembly may be adjusted back and forth in the recess of handle to change the offset position of the front face of bridge assembly **298** relative to lower vertebra **54**. Also, the orientation of the front face of bridge assembly **298** relative to the end plate of the lower vertebra may be changed by rotating handle **254** relative to hub **268**. Knob **270** may be tightened to fix the position of bar assembly **266** relative to the handle **254**. When bridge assembly **298** is properly positioned, the front face of the bridge assembly may be substantially parallel to the endplate of bottom vertebra **54**, and guide slots **300** are substantially vertical and equidistant from the vertical centerline of lower vertebra **54**.

Protrusions of instrument guides may be positioned in guide slots **300**. Guide releases **302** may include a spring or other bias member that extends an end of the guide release beyond the front face of the bridge assembly. The end of the guide release may extend into an opening of an instrument guide to couple bridge assembly **298** to the instrument guide. A grip may be pulled away from bridge assembly **298** to retract the end of guide release **300** and allow the instrument guide to be removed from the bridge assembly.

A first guide and a second guide may be placed in guide slots **300** of bridge assembly **298**. The first guide may be a mirror image of the second guide. When the guides are fully inserted in the guide slots of bridge assembly **298**, guide releases **302** inhibit movement of the guides. During some procedures, guides are positioned in guide slots **278** before the support frame is coupled to the taps.

FIG. **52** depicts a perspective view of first instrument guide **230'** used on a first side of the bridge assembly. First instrument guide **230'** may include protrusion **304**, opening **306**, passageway **232**, key **240**, and guide release **234**. Protrusion **304** may be placed in a guide slot guide slot of the bridge assembly. Protrusion **304** may be angled relative to passageway **232** so that the passageway is at a desired angle relative to vertical (and the lower vertebra) when the protrusion is positioned in the guide slot of the bridge assembly. In some embodiments, the angle of passageway **232** of the first guide **230'** and the angle of the passageway of the second guide are directed inwards toward the vertical center line of the lower vertebra at about 15° relative to vertical. When protrusion **304** is inserted in the guide slot of the bridge assembly, the end of the bridge assembly guide release extends into opening **306** to inhibit undesired movement of first guide **230'**.

A trial or inserter may be placed through passageway **232** of first guide **230'** that is positioned in the bridge assembly. Passageway **232** may include key **240**. Key **240** may fit in a keyway of an appropriate trial or inserter used with the first guide **230'**. When the appropriate trial or inserter is positioned in first guide **230'**, a spring or other bias member of guide release **234** may extend an end of the trial release into an opening in the trial or inserter to inhibit movement and allow a user to know that the trial or inserter is fully inserted.

FIG. **53** depicts an embodiment of first expandable trial **212'** that may be used to determine the appropriate height of a dynamic interbody device to be positioned between vertebrae. First expandable trial **212'** may be used in conjunction with the first guide. A second expandable trial, which may be a mirror image of first expandable trial **212'**, may be used in conjunction with the second instrument guide. Expandable trial **212'** may include body **214**, keyway **226**, guide recess **228**, rotator **216**, scale **218**, base plate **220** and movable plate **222**. Keyway **226** may extend along a portion of body **214**. When expandable trial **212'** is inserted into the first guide, the key of the guide is positioned in keyway **226**. Keyway **226** only allows the use of expandable trial **212'** with the appropriate guide. When expandable trial **212'** is fully inserted in the first guide, an end of the guide release of the guide may extend into guide opening **228** to inhibit further insertion of the expandable trial.

Rotator **216** may be located near a first end of expandable trial **212'**. A tool may be positioned in rotator **216**. Turning the tool may advance a shaft in the upper part of body **214**. Torque needed to turn the tool and advance the shaft may be offset by counter-torque applied to the handle of the bridge assembly. The amount of advancement of the shaft may be indicated on scale **218**. Scale **218** may indicate height corresponding to height between the upper portion of movable plate **222** and the lower portion of base plate **220**.

Turning rotator **216** extends the shaft against an actuator located in the lower part of body **214**. The actuator may engage a linkage mechanism coupled to base plate **220** and movable plate **222**. The actuator may push and move a linkage pin. The linkage pin is coupled to lifting arms. When the linkage pin is moved, the linkage arms raise movable plate **222** from base plate **220**. FIG. **38** depicts an end portion of expandable trial with movable plate **222** lifted above base plate **220**.

Before insertion through passages of the guides, the movable plates of the expandable trials may be adjusted relative to the base plates so that the movable plates and base plates can be inserted into the disc space between the vertebrae. The expandable trials may be inserted in the appropriate insertion guides so that the movable plates and base plates of the expandable trials extend into the disc space between the vertebrae. The base plates may be abutted against the end plate of the lower vertebra by loosening the knob of the bridge assembly and moving the base plates against the lower vertebra. The knob may be tightened to inhibit additional movement of the expandable trials relative to the lower vertebrae.

FIG. **54** depicts expandable trials **212'**, **212"** positioned in guides **230'**, **230"**. The rotators of expandable trials **212'**, **212"** may be turned in a first direction to lift movable plates **222** above the base plates **220**. The tool used to turn the rotators may include a torque gauge. The rotators may be turned until a desired amount of torque is applied. When the desired amount of torque is applied, the height indicated on scales

218 of expandable trials may correspond to the heights of dynamic interbody devices to be implanted between the vertebrae.

The appropriate dynamic interbody devices may be selected from the insertion kit. Each dynamic interbody device may be coupled to an appropriate inserter. The rotator of first expandable trial **212'** may be turned in the direction opposite to the direction that lifts movable plate **222** from base plate **220**. The grip of guide release **234** of first guide **230'** may be pulled and expandable trial **212'** may be removed from the first guide. The vertebrae may be prepared to receive the first dynamic interbody device. For example, a channel may be formed in a vertebra to accept a keel of the dynamic interbody device. The first dynamic interbody device may be inserted through first guide **230'** and into the disc space. The same procedure may be followed to insert the second dynamic interbody device into the disc space.

The portions of the inserters that fit in the inserter openings of the dynamic interbody devices may be retracted from the inserter openings. The portions of the inserter that reside in the curved slots of the second members and third members of the dynamic interbody devices may be rotated to remove the portions from the curved slots. The inserters may be removed from the guides **230'**, **230"**. Tap connectors **274** may be released and removed from taps **210**. Support frame **294** and instrument guides **230'**, **230"** may be removed from the patient.

Taps **210** may be removed from the vertebrae and bone fasteners of dynamic posterior stabilization systems may be inserted in the openings where the taps where positioned. Elongated members may be coupled to the bone fasteners to form dynamic posterior stabilization systems on each side of the vertebrae.

In this patent, certain U.S. patents, and U.S. patent applications have been incorporated by reference. The text of such U.S. patents and U.S. patent applications is, however, only incorporated by reference to the extent that no conflict exists between such text and the other statements and drawings set forth herein. In the event of such conflict, then any such conflicting text in such incorporated by reference U.S. patents and U.S. patent applications is specifically not incorporated by reference in this patent.

Further modifications and alternative embodiments of various aspects of the invention will be apparent to those skilled in the art in view of this description. Accordingly, this description is to be construed as illustrative only and is for the purpose of teaching those skilled in the art the general manner of carrying out the invention. It is to be understood that the forms of the invention shown and described herein are to be taken as examples of embodiments. Elements and materials may be substituted for those illustrated and described herein, parts and processes may be reversed, and certain features of the invention may be utilized independently, all as would be apparent to one skilled in the art after having the benefit of this description of the invention. Changes may be made in the elements described herein without departing from the spirit and scope of the invention as described in the following claims.

What is claimed is:

1. A dynamic interbody device configured to be positioned between a first vertebra and a second vertebra of a human spine, comprising:

a first member configured to couple to the first vertebra, the first member having an inferior surface configured to contact the first vertebra, wherein a portion of the inferior surface configured to be in contact with the first vertebra has a first width in a transverse plane of the human spine, wherein the first width comprises a maximum width of the portion of the first member configured to be disposed in an intervertebral space between the first vertebra and the second vertebra;

a second member coupled to the first member, wherein the second member is configured to move relative to the first member such that axial rotation of the first member relative to the second member results in lateral movement of the first member relative to the second member, and lateral movement of the first member relative to the second member results in axial rotation of the first member relative to the second member, and such that movement of the first member relative to the second member is configured to allow for coupled axial rotation and lateral bending of the first vertebra relative to the second vertebra such that axial rotation of the first vertebra relative to the second vertebra results in lateral bending of the first vertebra relative to the second vertebra, and lateral bending of the first vertebra relative to the second vertebra results in axial rotation of the first vertebra relative to the second vertebra; and

a third member coupled to the second member, the third member having a superior surface configured to contact the second vertebra, wherein a portion of the superior surface configured to be in contact with the second vertebra has a second width in the transverse plane of the human spine, wherein the second width comprises a maximum width of a portion of the second member configured to be disposed in the intervertebral space between the first vertebra and the second vertebra, wherein the first width is greater than the second width, and wherein the third member is configured to move relative to the second member to accommodate flexion and extension of the first vertebra relative to the second vertebra when the first member and the third member are coupled to the first vertebra and second vertebra.

2. The dynamic interbody device of claim **1**, wherein the first member comprises a keel.

3. The dynamic interbody device of claim **1**, wherein the second member comprises a portion configured to couple to a second dynamic interbody device.

4. The dynamic interbody device of claim **1**, wherein the second member comprises at least one tab, wherein the third member comprises at least one groove, and wherein a tab of the second member fits in the groove of the third member to couple the second member to the third member.

5. The dynamic interbody device of claim **1**, wherein the first member comprises at least one guide surface, wherein the second member comprises at least one guide surface, and wherein the guide surface of the first member interacts with the guide surface of the second member to couple the first member to the second member.

6. The dynamic interbody device of claim **1**, wherein the first member is coupled to the second member such that axial rotation of the first member relative to the second member causes lateral movement of the first member relative to the second member, and lateral movement of the first member relative to the second member causes axial rotation of the first member relative to the second member, such that movement of the first member relative to the second member is configured to accommodate coupled lateral bending and axial rotation of the first vertebra relative to the second vertebra such that axial rotation of the first vertebra relative to the second vertebra causes lateral bending of the first vertebra relative to the second vertebra, and lateral bending of the first vertebra relative to the second vertebra causes axial rotation of the first vertebra relative to the second vertebra.

7. A stabilization system for a first vertebra and a second vertebra of a human spine, comprising:

a first member configured to couple to the first vertebra, the first member having an inferior surface configured to contact the first vertebra, wherein a portion of the inferior surface configured to be in contact with the first vertebra has a first contact area, wherein the first contact area comprises a footprint of the inferior surface of the first member configured to be in contact with an end plate of the first vertebra in an intervertebral space between the first vertebra and the second vertebra;

a second member coupled to the first member, wherein the second member is configured to move relative to the first member such that axial rotation of the first member relative to the second member results in lateral movement of the first member relative to the second member, and lateral movement of the first member relative to the second member results in axial rotation of the first member relative to the second member, and such that movement of the first member relative to the second member is configured to allow for coupled axial rotation and lateral bending such that axial rotation of the first vertebra relative to the second vertebra results in lateral bending of the first vertebra relative to the second vertebra, and lateral bending of the first vertebra relative to the second vertebra results in axial rotation of the first vertebra relative to the second vertebra; and

a third member coupled to the second member, the third member having a superior surface configured to contact the second vertebra, wherein a portion of the superior surface configured to be in contact with the second vertebra has a second contact area, wherein the second contact area comprises a footprint of the superior surface of the second member configured to be in contact with an end plate of the second vertebra in the intervertebral space between the first vertebra and the second vertebra, wherein the first contact area is greater than the second contact area, and wherein the third member is configured to move relative to the second member to accommodate flexion and extension of the first vertebra relative to the second vertebra when the first member and the third member are coupled to the first vertebra and second vertebra.

8. The dynamic interbody device of claim 7, wherein the first member comprises a keel.

9. The dynamic interbody device of claim 7, wherein the second member comprises a portion configured to couple to a second dynamic interbody device.

10. The dynamic interbody device of claim 7, wherein the second member comprises at least one tab, wherein the third member comprises at least one groove, and wherein a tab of the second member fits in the groove of the third member to couple the second member to the third member.

11. The dynamic interbody device of claim 7, wherein the first member comprises at least one guide surface, wherein the second member comprises at least one guide surface, and wherein the guide surface of the first member interacts with the guide surface of the second member to couple the first member to the second member.

12. The dynamic interbody device of claim 7, wherein the first member is coupled to the second member such that axial rotation of the first member relative to the second member causes lateral movement of the first member relative to the second member, and lateral movement of the first member relative to the second member causes axial rotation of the first member relative to the second member, such that movement of the first member relative to the second member is configured to accommodate coupled lateral bending and axial rotation of the first vertebra relative to the second vertebra such that axial rotation of the first vertebra relative to the second vertebra causes lateral bending of the first vertebra relative to the second vertebra, and lateral bending of the first vertebra relative to the second vertebra causes axial rotation of the first vertebra relative to the second vertebra.

13. A stabilization system for a first vertebra and a second vertebra of a human spine, comprising:

a first member configured to couple to the first vertebra using a keel, the first member having an inferior surface configured to contact the first vertebra, wherein a portion of the inferior surface configured to be in contact with the first vertebra has a first contact area, wherein the first contact area comprises a footprint of the inferior surface of the first member configured to be in contact with an end plate of the first vertebra in an intervertebral space between the first vertebra and the second vertebra;

a second member coupled to the first member, wherein the second member is configured to move relative to the first member such that axial rotation of the first member relative to the second member results in lateral movement of the first member relative to the second member, and lateral movement of the first member relative to the second member results in axial rotation of the first member relative to the second member, and such that movement of the first member relative to the second member is configured to allow for coupled axial rotation and lateral bending such that axial rotation of the first vertebra relative to the second vertebra results in lateral bending of the first vertebra relative to the second vertebra, and lateral bending of the first vertebra relative to the second vertebra results in axial rotation of the first vertebra relative to the second vertebra; and

a third member coupled to the second member, the third member having a superior surface configured to contact the second vertebra, wherein a portion of the superior surface configured to be in contact with the second vertebra has a second contact area, wherein the second contact area comprises a footprint of the superior surface of the second member configured to be in contact with an end plate of the second vertebra in the intervertebral space between the first vertebra and the second vertebra, wherein the first contact area is greater than the second contact area, and wherein the third member is configured to move relative to the second member to accommodate flexion and extension of the first vertebra relative to the second vertebra when the first member and the third member are coupled to the first vertebra and second vertebra.

14. The dynamic interbody device of claim 13, wherein the second member comprises a portion configured to couple to a second dynamic interbody device.

15. The dynamic interbody device of claim 13, wherein the second member comprises at least one tab, wherein the third member comprises at least one groove, and wherein a tab of the second member fits in the groove of the third member to couple the second member to the third member.

16. The dynamic interbody device of claim 13, wherein the first member comprises at least one guide surface, wherein the second member comprises at least one guide surface, and wherein the guide surface of the first member interacts with the guide surface of the second member to couple the first member to the second member.

17. The dynamic interbody device of claim 13, wherein the first member is coupled to the second member such that axial rotation of the first member relative to the second member

causes lateral movement of the first member relative to the second member, and lateral movement of the first member relative to the second member causes axial rotation of the first member relative to the second member, such that movement of the first member relative to the second member is configured to accommodate coupled lateral bending and axial rotation of the first vertebra relative to the second vertebra such that axial rotation of the first vertebra relative to the second vertebra causes lateral bending of the first vertebra relative to the second vertebra, and lateral bending of the first vertebra relative to the second vertebra causes axial rotation of the first vertebra relative to the second vertebra.

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